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THE UNKNOWABLE;
OR,
THE RELIGION OF SCIENCE.

By RICHARD A. PROCTOR.

THE BIRTH OF RELIGIOUS IMPRESSIONS.

ALTHOUGH we may assign a definite position, in the development of the religious ideas of a race, to some particular class of thoughts, it must not be forgotten that there has been no process of religious stratification. We cannot say even of any man that in such and such a part of his life ideas of one class prevailed, which gave place later to ideas of another class, and these in turn to other ideas, and so forth; for even where a man has seemed to pass by quick transition from one "religion" to another, the transition has not in reality been sudden. The views which seem new have been long present; it has been only by a mental struggle that the older views have been maintained; and all which has in reality been sudden (if aught has) has been the cessation of the long struggle by which the gradual encroachments of more advanced ideas had been resisted. If this is so in the case of a single mind, we may be assured that there has been proportionate slowness of development, which means a much longer and more complicated process of change, in the religious ideas of races. We cannot truly say of any race,—at this part of its history the people believed thus, but at such and such a time they adopted this or that new belief. At every stage of the progress from the infancy of the race to such development as it may have attained, different forms of belief have co-existed, even where an outward uniformity may have been maintained.

It will not be idle, indeed, to digress here for a moment in order to consider the kindred lesson taught by the study of other subjects than that with which we are here dealing. In many departments of inquiry, perhaps in all, the mistake of imagining an undue uniformity and simplicity of arrangement has been made, and has seriously affected the progress of research. The earlier astronomers pictured a solar system of so many similar planets,—a galaxy of uniformly distributed stars; the geologist clothed the earth with a series of layers like the skins of an onion; the biologist of old times pictured races of animals as severally descended from single pairs; the historian imagined each people descended (as the biologist had imagined the whole race of man descended) from a single pair; the chemist had his four elements out of which all things were formed: throughout the whole range of what may be called the science of earlier times we find the underlying idea that the phenomena of science, history, sociology, and religion, are uniform, and the associated problems simple.

With all the progress of modern inquiry we find the old leaven apparent. In all departments of science, the less philosophic and thoughtful—who are altogether the more numerous—fall constantly into the mistake of overlooking the diversity and complexity of the processes which are taking place throughout the universe. In astronomy men pretend to say thus and thus did the processes succeed each other by which the solar system, or this or that part of the solar system, were formed,—when doubtless not only those processes of which the evident traces remain, but multitudes of others of which we have no evidence and no conception even, have taken place in varying degree at all times in the system, and are taking place now. Consider geology again,—How neatly the various eras of the earth's history are separated in the mind of the ordinary student of geology; how complacently he distinguishes the Eocene, Miocene, Pliocene, and other such periods (precisely as if all were actually seen) from each other, as though at one time the whole earth were clothed in one set of garments, at another in an entirely distinct set, and at another in a set altogether changed yet once more.

Or take a specific part of geological study, the formation of mountain ranges, which illustrates well the subject of religious evolution,—for we may aptly compare man's religious ideas, inherited or developed, newly formed or old and well worn, with the various forms of the earth's surface-contour:—

Even now, when geologists have learned to trace the actual processes by which a mountain range is formed, too many students of geology have entirely erroneous (because too simple) ideas of the way in which the mountain range reached its actual condition. They picture to themselves the various stages, when first the crust yielded and molten matter was extruded, then next the region thus broken and loaded sank gradually beneath the sea and became a vast trough along which matter was deposited, and after this trough had in the course of ages been filled (steadily sinking all the time to depths of many miles) the process was reversed and the great seam thus formed was gradually squeezed upwards by the side pressures of the yielding sea-floors around it, while lastly the action of denuding forces carved out of the upraised mass the peaks and pinnacles of the present mountain range. All this is right enough. Of all these processes we have in the Alps and Apennines, the Himalayas and the Rocky Mountains, very clear and decisive evidence. But the processes were not neatly defined and separated as the student is apt to imagine. The process of extrusion, for instance, did not cease when the process of sinking began, but went on still, at various places along the original region of yielding. Again the process of sinking with deposition was not uniform, nor did it give place everywhere to a process of uprising: both processes were going on, intermittently and irregularly, at the same time, while all the time the extrusion of matter was taking place, though now in new regions. Yet once more, sub-aërial denudation did not wait till the upheaval had been completed before it began its work, but went on in company with the process of upheaval, with the process of sinking, and even with the process of extrusion, all these processes acting with ever varying degrees of energy and efficiency, and often intermitting their action.

If a purely physical problem presents such complexity, even where the records of every part of the work are more or less clearly legible in the earth's crust, we may be well assured that the problem of religious evolution

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in any race of men is not to be solved by supposing that such and such religious ideas were successively formed, and successively displaced their predecessors. Probably there was never a race of men, however limited in mental activity, or wanting in originality, which held even for a single generation kindred ideas about religion. As certainly as among the savage inhabitants of a small island of Polynesia we find diversities of size, figure, complexion, strength, activity, intelligence, and the like, so, could the ideas of the tribe about matters religious be ascertained, it would be found that no two have thought precisely or even nearly alike. It is easy to imagine that they all have similar ideas, because only a few among them can be got to speak about their religious notions and even these few in answering the questions of a stranger can give but vague ideas of what they themselves believe and suppose to be the ideas of their fellows. If a member of some strange new race came among a community of Christians as found in some small European or American town, and speaking their language imperfectly were to ask the first nine or ten of them to define their religious belief, it is very likely that, even among a community with creeds and catechisms to define religion, he would obtain answers indicating a considerable diversity of opinion,—whether the persons questioned tried carefully to express their real thoughts, or as carefully tried to avoid any exact expression of opinion. It would be curious to inquire what such a stranger would be apt to infer respecting the Christian religion if he pursued his inquiry very carefully and earnestly. Probably if the experiment could be tried it would dispose us to adopt with considerable caution the accounts which have been collected of the various forms of belief entertained by savage races. Assuredly it would show that if among the members of a small community of Christians there is a marked diversity of views, there must be more marked diversity still among savage communities; and that therefore there can have been no such uniform development of religious ideas even in a single human race as some students of religious evolution appear to imagine. Still less can we imagine that in every race of men, there was the same succession of religious strata,—so to describe general ideas about matters religious as distinguished from definite religious dogmas.

I imagine then that while we must regard the general impression produced by natural objects, forces, and processes, as the embryonic form of the religious sentiment, individuality being ascribed to everything which influenced the life of the savage man, this impression was experienced in very different degrees by different races and by different members of the same race. How far back we may trace the beginning of this idea it were difficult to say; but it must have been present long before pastoral or agricultural pursuits began: it must have belonged to the time when our altogether wild ancestors, forest-haunting or cave-inhabiting, first became conscious of their constant contest with the forces of nature, with other animals, with their fellow men. We may even when we see our remote kinsmen the Gibbons welcoming the rising of the sun with noisy gesticulations, conceive that even in those mere animals the germ of the thought is present that the sun is a warm personal friend—a thought certainly adopted by many of the lowest races of savages, though it required many thousands of years of culture to develope it into a definite solar religion.

And if the vague idea of personality in natural objects or forces was diversely distinct in different minds even among small communities of child-men, how still more diverse must have been the way in which the idea eventually became developed that this personality was human and that the power and volition conceived to be present in sun moon and stars, in cloud and storm, in mountain and river, in trees and animals, were derived from men who had once lived upon the earth. Mr. Spencer's ghost theory is comparatively simple so far as it relates to the development of ancestor-worship as such; but manifestly we can only accept it in a very complex form as related to the development of nature-worship. Not only would different races of men, it may be presumed, form very different ideas of the way in which the spirits of the dead animated objects of different orders, from some small animal to the sun in his glory and the moon walking in light, but among the members of one and the same tribe there must originally have been great diversity of views on a subject such as this. We must remember that whatever ideas we may now find prevalent in a tribe of savages must have been initiated by individuals, and were probably only known to such individual thinkers for many generations. The hunter who was led by the varying fortunes of the chase to attribute good or evil influences to particular natural objects or phenomena, and so to conceive the idea that they possessed a personal individuality akin to his own, would probably keep the idea to himself—either because it would not be worth his while to do otherwise, or because it might seem well worth his while to keep such special knowledge of his to himself. And so with men who lived otherwise than by hunting. In many generations such ideas would be entertained, in very diverse forms, by individuals, before they began to be common property. But if this were so with that early and comparatively general notion, much more would it be apt to be the case when some among the members of a race began to attribute human personality to natural objects or phenomena.

The recognition of a second self, a soul or spirit, suggested by the phenomena of dreams, trances, catalepsy, and so forth, probably began earlier, and was more generally and uniformly diffused. For here specific phenomena, alike among all races of men, and not very different even among different individuals, were in question,—while the same phenomena were witnessed by many, were talked over by those who had witnessed them, and became in fact after a fashion matters of scientific inquiry. I imagine that among ninety-nine races out of a hundred and among nine men out of ten in any race,* the idea would be adopted that every man has a second self, which may leave him when he sleeps or becomes insensible, returning and reanimating his body when he comes to himself: (the very words now so familiarly used imply the old doctrine in its old form). One can see also that in the great majority of cases (that is among nearly all races, and among most of the individuals

* We find, however, that even these natural thoughts, not necessarily connected with religion at all, and likely, it would seem, to occur to nearly every one, are not entertained by all even among fairly developed races. I do not mean that they are rejected as the man of science of to-day rejects them, because of the scientific interpretation which shows the idea of a second self to be unnecessary and inexact, but that they have not presented themselves at all or have seemed inconceivable if suggested. Thus, Sir S. Baker asked Commoro a Latooki chief whether he did not know that he had "a spirit in him more than flesh. Do you not dream and wander in thought to distant places in your sleep? Nevertheless your body rests in one spot. How do you account for this?" to which Commoro who here and in the whole conversation showed much more acumen than his questioner, replied, laughing, that it was a thing he could not understand. "It occurs to me every night. How do *you* account for it?" (Observe that Baker had tried to account for it by an explanation which Commoro's better sense rejected—viz., by the idea that a spirit in him wandered to distant places during sleep.)

of each race) the idea would be entertained that the breath represented, or actually was, this second self; for in sleep the breathing is scarce perceptible. Thus the second self would be regarded as a spirit or breath, and death would come to be regarded quite generally as merely the prolonged, perhaps final, departure of the spirit or breath from the other or bodily self. In passing, too, we note that as the proper second self could pass away and return to its companion body, so on occasion other spirits good or bad might make that body their temporary home, giving in one case "inspiration" in a good sense (very definitely believed, I imagine, in old times to be what its names implies, an in-breathing) and in the other "possession" in an evil sense.

These ideas would prevail long before any idea of associating religious sentiments with them would be entertained, and still longer before the thought of assigning what had been human spirits to natural objects or powers would suggest itself even to the mere imagination.

PLEASANT HOURS WITH A MICROSCOPE.

BY HENRY J. SLACK, F.G.S., F.R.M.S.

AMONGST the insects injurious to man, aphides occupy a prominent place, and no species are worse than the Cotton Bugs, or American Blights. A visit to an orchard assailed by these creatures presents a curious aspect, the branches and twigs glistening with white, cottony-looking threads. Under this cover lie multitudes of the insects. The slightest touch of the finger squashes scores of them, and makes a nasty brown stain. A hand-magnifier discloses the family parties. Young and old are seen all higgledy-piggledy together in what might be supposed a wretched condition of overcrowding, but they are quite happy in their way.

The microscopist should cut off some portions of the afflicted twigs, and keep them for a few days in a box with a glass lid. This allows their rapid multiplication to be noticed; but as the sap dries up, the bigger ones soon die. The cottony stuff hinders observations of any details, but it may be got rid of quickly by immersing the insects in a drop of alcohol, and stroking them very gently with a fine needle or a bristle. The older ones are so swollen out with the tree sap that a slight touch bursts them, and it is then common to find a number of young ones escaping, some in a very forward condition, others in an embryonic state. The adult viviparous females have their bodies longer than their rostra, but the little ones have their rostra considerably longer than their bodies. The very early development of the sucking and piercing mouth-organs is a striking fact in the life history of these creatures. The rostra look quite out of proportion to the rest of the new-comers, but it enables them to practise their voracity with the least possible delay. In the adults, as well as in the young, the piercing organs, consisting of three fine tubular, sharp-pointed bristles, are of great length — much longer than the bodies of the full-grown creatures. This allows them to swarm in clusters, one atop of another, and all sucking away together. The young ones can move actively, but they do not leave the family party in which they are born until the numbers render emigration indispensable, and then they usually settle close to the old group, and do nothing but fill themselves with the plant-juices and bring forth more young. The antennæ are small, and the two top joints provided with curious depressions, surrounded with hairs, much like that shown in the sketch of the antennæ of the phylloxera in KNOWLEDGE, August 28. (See Fig. 2.)

The belief that antennæ may be organs of hearing is strengthened by the occurrence of such formations. They are hollow, with drum-like membranes stretched over the bottom, and may be sensitive to very slight sound-waves. Neither hearing nor seeing, however, could be of much use to a cotton bug. The eyes are very small, and probably little used, as the vast majority of the insects pass their lives huddled together where they are born, covered with the cotton, and those that migrate from the family heap, for the most part only move a quarter or half an inch further on the part of the plant that is attacked.

The founder of a cotton-bug family is a viviparous female, called a Queen aphis by Mr. Buckton. She is larger than the one figured from him in the sketch No. 1, and black. She is the product of an egg laid by an impregnated female in a crevice of apple-bark, and, acording to Buckton, she often dies before laying her egg, in which case her body serves as a protecting cover.

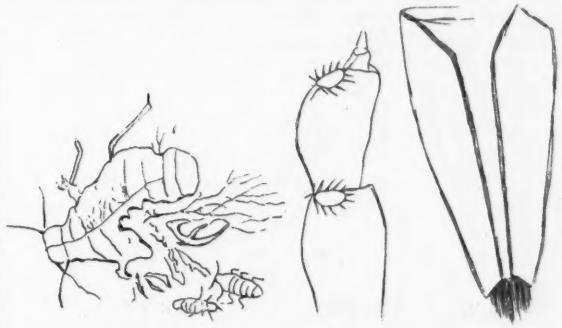

Fig. 1. Fig. 2. Fig. 3.

Fig. 1 shows one of her adult children, the little streamers being the cotton threads they exude. The young are produced at a rapid rate, so that long twigs are covered almost as soon as they are attacked, and only a sharp eye detects the presence of the enemy before the trees are infested with thousands, and conspicuously whitened with the cotton down. Cold does not readily disagree with these creatures. Mr. Buckton speaks of finding them plentiful when the thermometer stood at 21° F.; and the writer noticed the same thing on the 18th of November, when the night temperature on the grass fell to 24° F., and must have been a few degrees lower where the aphides were thriving in a bitter east wind. Violent rains are much more destructive, and after two or three days of downpour, several trees that had been thickly infested were washed quite clean. When the trees are small, like pyramids, bushes, &c., painting the affected parts with strong size is the best remedy; but this is impracticable with large old ones, and they perish under the attack. The rough knots that disfigure branches are caused by the irritation of these creatures, and some are said to assail the roots.

The rostrum, or snout, is of the same pattern as in other aphis species, but it is very stout and strong, and at the tip has stiff, rough hairs, as shown in Fig. 3. Pressure in mounting opened the gap wider than it is in nature. Some curious structures are found on the back of the insects. Near the antennæ they make pretty

rosettes, as shown in Fig. 4. Others are larger, of which a specimen is given in Fig. 5, taken from the tail end. Under a high power, minute, dot-like projections are seen, but I could detect no openings, and do not know what they are. Mr. Buckton does not mention them.

I have not been fortunate enough to see the cotton-down exuded, or to find the organs exuding it.

Putting some bits of twig covered with the creatures in a box with a glass lid facilitated watching them. They could not have obtained much nourishment, as the twigs soon dried up, but the young were produced in great numbers. Not one, however, put forth a particle of the cotton stuff.

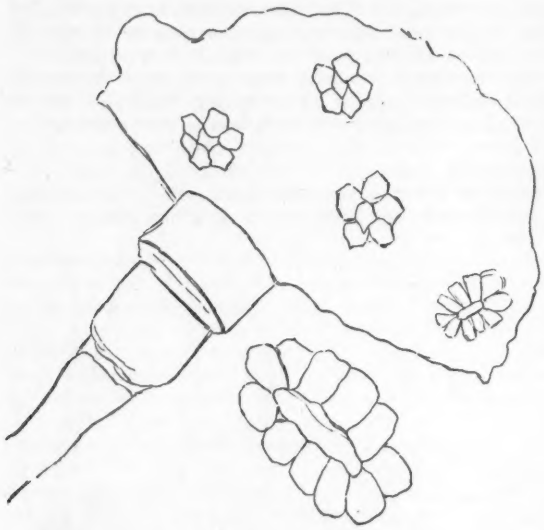

Fig. 4. (× 320.) Fig. 5.

Like the rest of their tribe, they are difficult to dissect. The operation is facilitated by a little glycerine, and more can be done in a drop of methylated spirit than in plain water. The tracheal system is well developed, and some of the larger vessels are easily distinguished amongst the miscellaneous matter that comes out when a specimen is squeezed in a water drop. It is then easy to pick out some tracheæ with a mounted needle.

Besides the apple-tree plague, other species attack elms, dogwoods, &c., and, on the whole, they are among the worst of the insect plagues. America is credited with their origin, and hence they are often called "American Blight." Like other aphides, they chiefly multiply by viviparous broods. The males occur late in the season, and are not often seen. They are born with a rostrum, but Mr. Buckton observes, "the rostrum would seem to disappear at the subsequent moult. The sex is finally blind as well as mouthless." The oviparous female is also described as destitute of a sucking organ. The viviparous females occur in a winged form as well as in a wingless one, and Lichtenstein, cited by Buckton, says they swarm in September in the south of France.

The organisation of these creatures seems above the necessities of their way of life. As individuals they deteriorate as they pass from infancy to the adult stage. Any action of rudimentary intelligence ceases when they have fixed their mouths in a good place, and penetrated to the sap vessels. They have then nothing to do but suck and bring forth numbers of their kind.

The scientific name of the section of aphides to which the Cotton Bugs belong is Schizoneurinæ, from the Greek *schizo*, to cut, and *neuron*, a nerve. It refers to the furcations of the veins in the winged forms. The Cotton Bug of the apple is *Schizoneura lanigera* (wool-bearing). *S. ulmi* attacks the elm. *S. lanuginosa* forms gall-like masses at the ends of the twigs of *Ulmus campestris* and *U. suberosa*, which are densely hairy (Buckton). *S. corni* assails dog-wood.

THE STORY OF CREATION.

A PLAIN ACCOUNT OF EVOLUTION.

By Edward Clodd.

III.—DISTRIBUTION OF MATTER IN SPACE.

MATTER, as explained in the foregoing section, is both visible and invisible, ponderable and imponderable. In its ponderable form it is distributed throughout space in bodies of varying densities; in its imponderable form as ether it fills the intervals between the particles composing those bodies, as also the vast intervals between the bodies themselves. The most important of these—as the sand by the seashore, innumerable—are the "fixed" stars, so called from having no apparent motion of their own, although, in reality travelling at enormous velocities. Each of these, unless it be an extinct, burnt-out sun, shines by its own light, and is probably the centre of a system of planets with their satellites or moons, and other bodies, as is our sun, which is itself a star. "One star differeth from another star in glory." Not, speaking broadly, in the stuff of which all are made, for the light thrown by the spectroscope on the chemistry of the heavenly bodies has revealed their general identity of structure. No matter how distant the star, so long as the light emitted is strong enough; broken on prisms, it reveals through its spectrum not only what elements are present in the glowing vapour, but even the direction of the star's motion, *i.e.*, whether it is receding from or approaching our system. The nearest fixed star is Alpha Centauri, the annual parallax of which (that is, the apparent change of position as seen from opposite points of the earth's orbit) is nearly one second of arc, giving a distance of twenty millions of millions of miles. Its light, travelling 186,000 miles per second of time, therefore, takes nearly three years and a half to reach us, and so vast is the interval that, viewed from this star, our solar system appears as only a point in space.

The differences between the stars are in their sizes, their brilliancy or magnitude, and their colours, this last giving some clue to their stage of development. For there are stars young, middle-aged, old and decrepid; and there are stars cold and dead, radiating no energy, and whose existence can be known only by their influence under the force of gravitation upon other bodies.

The astronomer has not arrived as yet at any certain conclusions regarding the general distribution of matter in space. But the combinations, as seen from our system, are as varied as they are complex. Besides double and multiple stars—their apparent nearness often being due to their lying in nearly the same straight line from our system—there are the constellations, many of the names of which are relics of that animistic stage in man's belief when everything was personified. There are star-clusters, light, cloudy-looking patches, made up of suns which, from our point of view, lie densely packed together in galaxies numberless as the bodies that compose them.

Besides the fixed stars and their systems, straggling in scattered groups on either side of the Milky Way or composing its cloud-like arch, there are the vast masses of glowing matter called, in contradistinction to the stellar nebulæ, which the telescope has resolved into stars, gaseous nebulæ. These are of regular and irregular form—circular, elliptical, spiral, and so forth ; they are the raw stuff of which suns and systems are being formed. These nebulæ ; the fixed stars ; with whatever appertains to them, and the vagrant bodies known as comets, with their more or less associated meteor streams, comprise the ponderable matter of the universe. The sum-total of their radiant energy, save the small proportion intercepted by one from the other, is ever in course of transfer to the imponderable ethereal medium.

The results of modern research into the structure of the universe, in which inquiry Mr. Proctor has taken so distinguished and important a part, and who therefore speaks "as a man having authority and not as the scribes," is thus summed up by him in the article on "Astronomy," contributed to the last edition of the "Encyclopædia Britannica" :—

The sidereal system is altogether more complicated and more varied in structure than has hitherto been supposed; in the same region of the stellar depths co-exist stars of many orders of real magnitude; all the nebulæ, gaseous or stellar, planetary, ring-formed, elliptical and spiral, exist within the limits of the sidereal system; and, lastly, the whole system is *alive* with movements, the laws of which may one day be recognised, though at present they are too complex to be understood.

THE SOLAR SYSTEM AND ITS MEMBERS.

The Sun is by no means the biggest of the stars, and, as compared with them in brightness, he probably does not exceed the third or fourth magnitude. But he has the greatest interest and importance for us, seeing that to him are due those manifold energies by which the processes of nature, both chemical and vital, are carried on here and elsewhere. And, with the knowledge which has been gained during late years concerning the sameness of the stuff of which nebulæ, stars, and planets are spun, the nature and arrangement of the contents of our solar system may enable us to make lawful analogies concerning the contents of systems beyond it. The Solar System comprises: 1, the Sun; 2, the Planets, large, small, and minor; 3, Moons or Satellites; 4, Comets, together with meteors or shooting-stars.

The sun, whose volume exceeds several hundred times all the other members of his system combined, is the principal and indispensable source of ceaseless energy radiant as light, heat, and chemical action, to them. Of this energy the planets receive or intercept but the 230 millionth part, the earth receiving but the 2,170 millionth part, and even the larger proportion of this energy is ultimately radiated by them into space. The planets, one and all, revolve in nearly circular orbits, but on rather differently inclined planes, round the sun, in virtue of that energy of orbital motion with which each was endowed at birth, and which counteracts the opposing force of his gravitation, which would otherwise pull them into him, absorbing them in his mass. Including the swarm of minor planets or asteroids, of which new ones are being frequently discovered, they are perhaps to be numbered by thousands, and are of various sizes and densities, and in different stages of progress and decay. The evidence for the primitive gaseous state of all bodies now possessing greater density will be given hereafter, but our system itself supplies illustration of the passage of planets and satellites to an increasingly solid form. Some, like our Earth and Mars, have cooled down sufficiently to be covered by a solid crust, and to be fit abode for living creatures; others, like Jupiter and correspondingly huge bodies, are still in a more or less heated and partly self-luminous condition. The smaller bodies have long been cold and inert, like our airless, barren moon. In her pale, reflected light and scarred surface, illumined no longer by flame of central fires, we learn that what she is, planets and the sun himself will one day become.

The moons revolve round their several planets under similar restraint of force and freedom of energy as the planets themselves. The gaseous masses composing comets and meteor-streams travel in very eccentric orbits. In fine, motion is everywhere, in ether, atom, molecule, and mass; the sun, like his fellow stars, has his proper motion, carrying with him planets, satellites, and whatever other bodies are within the curb of that force of his gravitation which is itself obedient to the attraction of bodies perchance as much exceeding his own in power as he exceeds the mote dancing in his beams.

THE EARTH.

The mass of matter called the earth is of nearly spherical shape, being slightly flattened at the poles and bulged towards the equator.

It consists of a core enclosed within, and connected with, a cool, solid crust, three-fourths of which is covered by a layer of water, and the whole surrounded by an atmosphere.

The entire mass, solid, liquid, and gaseous, spins on its axis at the rate of about 1,000 miles every hour, and speeds through space in its orbit round the sun at the rate of 1,000 miles every minute.

The atmosphere is composed, in the main, of the uncombined elements oxygen and nitrogen; the water is chiefly compounded of combined but mobile oxygen and hydrogen. Of every hundred parts of the crust, ninety-nine are made up of about sixteen out of the seventy elementary substances, and of these sixteen the larger number exist in small proportion. It is computed that fully one-half of the crust consists of oxygen which it has taken into itself from the atmosphere, and that already one-third of the water of the ocean has been absorbed by minerals. These are matters to be remembered when dealing with the energies which have modified the structure and composition of the framework of the earth. The average density is about five times and a-half that of a globe of the same size made of pure water, but the large extent covered by the ocean in the southern hemisphere, whither the tendency to collect was probably manifest at the outset when the steamy vapours condensed and filled the depressions in the crust, point to an excess of solid matter in that direction.

What the inside of the earth is like no man can tell. But it is probably solid throughout, and in a state of intense heat at no very great depth, as manifest in volcanic outbursts and allied phenomena. These show that the earth has not yet lost the whole of the original store of energy which it acquired during the aggregation of the particles of which it is built up in their passage from a diffused nebulous state to one of increasing densities under the action of the force of gravitation. But the escape of that energy through the crust to the ethereal medium is unintermittent, and its final dissipation into space is therefore only a question of time.

The crust was probably never uniformly smooth, because the contraction of the interior mass as it cooled would bring about a state of tension causing shrinkage of the surface. Hence would be the beginnings of those

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wrinkled, and cracked, and crumpled features which other agencies would score more deeply in the face of the globe, but which bestowed thereby a beauty and variety in valley, mountain, and table-land that no even surface could boast.

Our knowledge of this crust extends to only a relatively small depth, the aggregate thickness of the strata or layers of rock already measured being about twenty-five miles, or the one hundred and sixtieth part of the earth's semi-diameter. The term "rock" is applied alike to hard granite and loose sand, to ore veined with metal, and to mud from country lanes, as including the materials comprising the crust or shell. Rocks are divided into two classes—unstratified and stratified. The *unstratified*, which are also called igneous or Plutonic, embrace all rocks which, as they now exist, have been fused together by heat, or erupted from the earth's interior by volcanic agency. The *stratified*, which are also called aqueous or Neptunic, embrace all rocks which have been deposited as sediment by the action of water or air, or which are due to the growth and decay of plants and animals. With this class are grouped the *metamorphic*, stratified rocks which have been metamorphosed into a crystalline state by the action of heat and pressure, resulting in effacement of their original character. Throughout the entire series of rocks the newer have been, and are being, formed out of the older, which, unless upheaved, are always found at the bottom; but of the original crust not a trace remains.

The depths to which the unstratified rocks extend is unknown, and as they contain no organic remains whatever, they tell us nothing concerning the origin and successions of life on the earth. Their place in the continuity of geological history will appear as we advance; meanwhile we may pass to brief glance at that section of the calendar which deals with the stratified groups. For convenience sake, and not as implying any gaps between their several formations, save where natural causes have operated, they are divided into five epochs. These, together with the typical remains of plant and animal associated with each, are shown in the following table:—

Epoch.	*Thickness of strata.*	*Plant.*	*Animal.*
Archeolithic or Eozoic (*i.e., dawn-life*), chiefly Metamorphic ...	70,000 ft.	Algæ*	Monera.*
Primary or Palæozoic (*ancient life*)	42,000	Ferns	Fishes.
Secondary or Mesozoic (*middle life*)	15,000	Pine-forests	Reptiles.
Tertiary or Cainozoic (*recent life*)	3,000	Leaf-bearing forests	Mammals.
Quaternary or Post Tertiary.....	...	Existing species.	

COAL.

By W. Mattieu Williams.

CANNEL COAL AND BOGHEAD.

CANNEL coal or "candle coal," so named because some varieties are so highly bituminous that a tapered piece may be lighted at its angle and will continue for awhile to burn like a candle, differs mechanically from ordinary bituminous coal in being harder and far more compact and homogeneous in structure. One result of this is that it may be freely handled without soiling the fingers. Some varieties of cannel coal resemble anthracite at first sight and handling, but an expert can easily distinguish them. Anthracite is more lustrous than cannel. Whitby jet is a sort of cannel.

One peculiar character of the cannels that are the richest in flaming constituents is the "streak." Although the coal itself is black, whether the fracture be new or old, if it be scratched with the point of a knife the streak thus made is brown. The value of a sample for gas-making may be roughly tested thus—the lighter the streak the richer the coal.

Some cannels have a fracture which is quite smooth and uniform, and slightly concave or conchoidal; others are curiously different. They appear to be made up of an agglomeration of circular constituents, like wood knots, and accordingly receive the name of "curly cannel." The celebrated Wigan cannel is somewhat curly, but the most characteristic display of this curious structure is afforded by the Flintshire curly cannel, found in the neighbourhood of Leeswood and Coed Talon, near Mold. In many of the cottages of the thrifty colliers of that neighbourhood a lump of this, carefully black-leaded to display the curls, may be seen displayed in the best Sunday room as a mantelpiece ornament.

In this Leeswood seam the curly and the smooth cannel lie in direct contact; first about 2 feet of smooth cannel, below this about 18 inches of curly cannel, and at the bottom of the curly 15 to 18 inches of bituminous shale. The roof shale overlying the smooth cannel is black, but only slightly bituminous. The fact that has puzzled me in studying this deposit is the absence of any gradation between the smooth and the curly; the transition from one to the other is curiously sharp, although they differ not only in structure and appearance, but also in composition, the curly cannel being much richer in gas-yielding constituents than the smooth in the proportion of about three to two (Dr. Andrew Fyfe's figures are 14,280 feet of gas per ton of curly, and 9,972 per ton of smooth. Wigan cannel 12,010).

The cannel coals generally yield a larger quantity of gas than ordinary bituminous coal. Both vary greatly in this respect, as the above figures show, but taking a rough average, the quantity may be stated as about four to three in comparing cannels with good gas coal.

But the value of cannel in making gas for illuminating purposes must not be measured merely by this. Comparing equal quantities, the value of the cannel gas burnt in ordinary manner is far greater than that of gas made from ordinary coal. There are good chemical reasons for this, which I will endeavour to explain.

The gas in both cases is a hydro-carbon; but there are hydro-carbons and hydro-carbons, *i.e.*, compounds of carbon and hydrogen, in which the elements exist in varying proportions. For illuminating purposes we may have too much carbon or too much hydrogen. In the first case, the flame is lurid and smoky, unless special devices are employed for supplying an excess of oxygen or of heated air. In the second case, the flame is deficient in luminosity, is bluish and feeble, approaching to that of an alcohol spirit lamp.

There is a series of hydro-carbons which are technically described as having a composition of $C_nH_{2n\times2}$, and another series whose composition is represented by C_nH_{2n-6}. Those accustomed to chemical formulas will at once perceive that the first of these all contain a larger proportion of hydrogen than the second, that whatever figure is represented by $_n$, the number of equivalents of carbon in the first must always fall below those of the hydrogen, while in the second they must equal or exceed it.

The first is the Marsh-gas, or paraffin series of hydro-

* Both marine.

carbons, the most volatile or gaseous and least complex of which is Methane, CH_4; the second is the Benzine series starting in like manner from benzine, C_6H_6. Having promised at the outset not to mystify the non-technical reader by an unintelligible display of my own technical erudition—(a proceeding as easy as grinding a barrel-organ when one has a text-book at hand), I will simply add that the various distallates from cannel,—whether they be gaseous at ordinary temperatures; or volatile liquids like the miscalled "benzoline" used in sponge-lamps; or less volatile liquids such as common paraffin oil and lubricating oil; or solids like the material of paraffin candles—all contain fewer equivalents or atoms of carbon than of hydrogen, and all of those similarly obtained by the distillation of ordinary bituminous coal contain equal or excessive equivalents of carbon. In consequence of this the paraffin or cannel series burns with a whiter, more luminous, and less smoky flame under ordinary conditions than the series from ordinary coal. Cannel gas properly made and burnt in a suitable burner has about double the illuminating power of ordinary coal gas.

The superior value of cannel gas is shown by the following figures, which I take from Clegg's "Treatise on Coal Gas." A cubic foot of gas from Newcastle Coking Coal (Pelton Main) burnt in a small batswing burner gave an amount of light equal to 232 grains of sperm, with an Argand burner 311. Newcastle cannel gas gave an average of 606. This double value is of great importance to the consumer, as the heat and the mischievous products of combustion are foot for foot about equal in both cases. With unmixed cannel gas, one burner gives as much light as two of ordinary gas. Corporations that are sufficiently civilized to make their own gas, give the benefit of this to the consumer; but we poor company-ridden cockneys are supplied with gas as bad as the Act of Parliament permits, and thus have to burn a larger quantity and pay our tyrants accordingly.

At the time when I commenced distilling coal and shale, it was generally stated on the authority of Reichenbach, that the production of the paraffin series depended on the low temperature of distillation. The claim in Young's patent was based upon this assumption, and the celebrated case of Young & Fernie was decided accordingly. I soon discovered, however, and others similarly engaged did the same, that this was quite wrong; that whatever be the temperature of distillation in either case, each kind of coal produced its own distinct hydro-carbon series; that by no mere variation of temperature could bituminous coal be made to yield the marsh gas or paraffin series, nor by any such variation could the cannel coal, or the black shale associated with it, be made to yield the benzine series or napthalene. Variations of temperature affected the specific gravity and volatility of the products—*i.e.*, the proportions of the different members of the series, but did not convert one series into the other. I state this with especial emphasis, because it is still but doubtfully understood by laboratory chemists, though clear enough to gas-makers and shale-distillers; and further and more particularly because it has an important and unrecognised bearing upon the whole theory of the formation of coal.

The theoretical question it raises is this. Does the existing vegetable kingdom present us with any great class or classes of plants that yield upon distillation a hydro-carbon series corresponding to that obtained from cannel coal; and is there any other class or classes that yield a series similar to that obtained from ordinary bituminous coal? If so, we are justified in referring their origin to such classes respectively.

Everybody knows that the tar used by sailors has a near physical resemblance to ordinary coal-tar, and that it burns with a similar smoky flame; the chemist recognises a similar close resemblance, though not an absolute identity. The tar and pitch used on board ship are obtained by distilling coniferous plants, pines, larches, firs, &c. Turpentine and resin are also obtained. Turpentine, resin, "Stockholm tar," and pitch are a family series, varying in boiling-points or volatility. They differ only slightly in their chemical composition from the series obtained from similar distillation of ordinary bituminous coal, and this difference is just such as exposure to oxidation, or, more especially, to the action of water, will effect.

My chemical readers will understand the force of this when I remind them of the fact that terebenthene, $C_{10}H_{16}$, the type of the turpentine and resin series, is readily converted by the action of bromine and iodine into cymene, $C_{10}H_{14}$, a typical member of the benzene or coal-tar series, and that similar acids are obtained by the oxidation of both series.

The camphors distilled from laurels and the naphthas from most of our forest trees have a similar close resemblance to the coal-tar series, but they all stand apart and keep apart from the marsh-gas, or paraffin series, obtained by the distillation of cannel.

Does any existing vegetation produce this last-named series? I am able to reply to this question, having distilled compressed peat in substantial quantities (one sample amounted to twenty tons), in the same retorts as were used for cannel. Excepting that the proportion of ammonia was much greater from the peat and the hydro-carbons very scanty, the results were the same; the hydro-carbons were distinctly of the paraffin series, and, when refined, were undistinguishable from the cannel products. In the crude state, their aroma was somewhat different.

Peat is made up of defunct mosses, cryptogamous or non-flowering plants. Here, then, we have a clearly defined and rather broad distinction. I am not prepared to assert that all the cryptogamia will yield the same results on distillation, my experiments on other members of this great subdivision of the vegetable kingdom being too limited for this; but they go far enough to justify further investigation.

The evidence supplied by the marsh gas itself points in the same direction. The vegetation of marshes is chiefly cryptogamic, and the gas is due to a slow distillation of the remains of such vegetation.

These facts obviously suggest the hypothesis that cannel deposits are ancient and fossilised peat bogs, while ordinary bituminous coal is the material of ancient forests. The idea that coal seams generally are ancient peat bogs much consolidated by pressure is an old one that has been much discussed, but the above-stated chemical facts indicate pretty clearly that we must be cautious in accepting any sweeping generalisation that applies alike to the formation of all coal. We must remember that both cannel and ordinary coal are found in the same coal-fields, though usually separated by mineral strata. The chemical differences, therefore, cannot be due to differences of pressure or subterranean temperature. *A specifically different material must have been originally deposited.*

Intimately associated with cannel are the bituminous shales. All that I am acquainted with yield the same products as cannel on distillation. There may be some

XUM

exception to this, but I have not yet heard of any. So intimately are they connected that the most remarkable example is frequently described as "Boghead Cannel," and a great lawsuit (Gillespie *v.* Russell) was fiercely fought in Edinburgh to determine whether it is coal or not coal. The landlord of Torbane Hill (Gillespie) granted a lease of all the coal on the estate to be worked by Russell. The mineral in question proved to be of far greater value than ordinary coal, on account of its yielding the paraffin series on distillation. At this date (1853) the Americans had not "struck ile," and the paraffin oil now selling at about 9d. per gallon in this country, was worth 3s. 6d. per gallon here, and even more in America. The Torbane Hill mineral was exported to the United States for the distillation of Kerosine there. Russell was consequently making a magnificent income, which excited the cupidity of his landlord, who denied that the lease gave a right to work this mineral, on the ground that it is not coal, and he proceeded accordingly.

I was living in Edinburgh at the time, and followed the proceedings with much interest. Geologists, chemists, microscopists, &c., were imported from all parts of Europe by both litigants, one set to swear that it was coal, the other to swear the opposite. I was then younger and greener than I am at present, and had a correspondingly profound respect for such titular appendages as F.R.S., &c., than I now have. My simple-minded faith received a painful shock on noting that all the distinguished fellows, graduates, and even professors who were subpœnaed (and paid) by Gillespie, found that the mineral in question was not coal, and all engaged in like manner by Russell discovered, on purely scientific grounds, that it was coal.

The best hotels of the city were filled with these distinguished men, and Edinburgh was in quite a britishassociationish state of scientific gala. Preparations were made, reports, proofs, and briefs were prepared, and all were ready for the fight; none more eager than the scientific combatants. Suddenly all the scientific edifice, or rather two edifices, collapsed like houses of cards. The judge set aside the learned gentlemen, and called for the evidence of colliers and coal merchants, who proved that when the lease was granted the mineral in question was known to exist, and vulgarly bore the name of coal—was worked and bought and sold as coal. Such being the case, the judge ruled that it was included in the contract, and the jury found accordingly for the defendant. The question was purely commercial, and was justly decided on commercial grounds. I need scarcely add that I heartily agree with the decision, though, as I shall show in my next, the Boghead mineral belongs to the class of bituminous shales, which differ widely from true coal.

A FUTURE FOR THE ENGLISH FARMER.—Let the farmers of England once realise the fact that they can make better cheese and butter and rear finer cattle than any country under the sun, and that they can not only supply all England with these commodities, but they can be very formidable rivals in foreign markets. Have not the Americans themselves paid prices for single English cows that would purchase a first-class farm and build model farm-buildings! Let farmers only reflect upon the enormous wealth that lies at their doors, and wake up to modern systems, and not be above learning. The Americans, wise in their generation, have from time to time sent over agents to England to inquire into the best modes of procedure, and they have improved their dairies in accordance with any excellence they may have seen in the old country. But let farmers learn from them, and not stand still; and if they take to heart some of the lessons they may gather from the various agricultural reports made by men of high credit, they will see that their case is a hopeful one. —*English Illustrated Magazine.*

OUR GALAXY.

LETTER TO SIR J. HERSCHEL.*

By Richard A. Proctor.

London, Aug. 8, 1869.

I SHOULD have written sooner to thank you for your very kind and encouraging letter, but for great pressure on my time. I wish also to mention, when writing, certain points I had accidentally omitted from my former letter.

You are not to suppose that I write now to meet the objections you have mentioned against my notions respecting the Milky Way, though I may have occasion to do so as I proceed. I do not wish to regard my views as something to be defended. I should have studied your writings and example to little purpose if I took this line. I may not hope, perhaps, to attain easily that placidity with which you are able to urge or to consider objections *against* hypotheses whose strong points you had shortly before exhibited; but I have at any rate definitely set that quality before me as the one which is of all others the most valuable to the searcher after truth.

First of the omitted facts is the discovery made by Lieut. Herschel that rich star-clusters sometimes show—besides the continuous spectrum—the bright-line spectrum of the gaseous nebulæ. This fact seems to me to be of the utmost importance. We find in it a fresh bond of union between all the members of the nebular family. Mr. Huggins had shown that the planetary nebulæ are all gaseous. Your own researches had confirmed this and had rendered it highly probable that all the irregular nebulæ are also gaseous. On the other hand, it had seemed that the clusters are a class apart, while the irresolvable nebulæ (not belonging to planetary or irregular classes) seemed to occupy a position midway between the two classes of gaseous and stellar nebulæ; since they showed in about equal proportions bright-line or continuous spectra. I was so convinced that this separation of the nebulæ into sets would be done away with after awhile, that I asked Mr. Huggins if it had occurred to him to look for signs of the bright-line spectrum superposed on the continuous spectrum given by the stellar nebulæ. He answered that his own view was similar to mine, but he had hitherto been unsuccessful in proving its justice. Lieut. Herschel's observations have supplied the necessary evidence. It is scarcely necessary to dwell on the significance of the facts thus brought together, (I repeat some facts already referred to):—

1. Irregular and planetary nebulæ affect neighbourhood of the Milky Way.

2. Irresolvable nebulæ segregate themselves from the Milky Way.

3. Clusters imitate the behaviour of the gaseous nebulæ.

4. The first and third sets of nebulæ belong to the extreme classes as respects gaseity or non-gaseity.†

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* This letter, like that in No. 1, New Series, is from the rough draft of the letter actually sent; and I am unable to say in what degree the latter differed from the first form. I am under the impression that I sent a much condensed letter. It is so unusual with me to make a draft of any letter I may have to write that I feel sure I eventually sent a letter differing much from the present in form; but on the other hand the circumstance that I kept the rough draft convinces me that in substance this letter presents what I actually wrote.

† When we arrange the nebulæ (I.) in order of their apparent stellarity, (II.) in order of their gaseity, and (III.) in order of their

But, 5. All the classes of nebulæ are brought together again by the discovery that their gaseity is simply a question of proportionate degree.

6. All the classes (including the irregular class) are brought together in the Magellanic Clouds.

The main inference from this little set of facts, is that the gaseous matter so common in the nebulæ exists in all parts of the galactic system, and serves as a sort of index of the oneness of the sidereal and nebular systems.

The second omitted fact is the discovery made in recent times of the singular complexity of the solar system. Forced to take the solar system with which we suppose ourselves familiar as presenting in a general way a type of the wider system of which it is a part, we clearly are led to form different views now than analogy suggested when as yet astronomers knew so little of our system. The discovery of the asteroids has done much towards this change of view; but I think the knowledge recently acquired respecting meteor-systems tends much more importantly to give us just conceptions of the richness and complexity of our solar scheme. I do not so much refer to the strange discoveries recently made respecting the orbits of the meteors, the association of these bodies with comets, and so on; though the evidence on all these points seems too definite and complete to leave any room for question respecting them. The point to which Prof. Herschel has called so much attention—I mean the large number of meteoric systems which our earth traverses—and the consequent argument from probability that there exist millions of such systems within the solar scheme—seems to me far more important. It teaches us to look for an enormous wealth of relatively minute bodies in other systems, and therefore prepares us to look on the "suns" in the sidereal scheme as relatively few, the minute orbs and the groups of minuter orbs as relatively numerous.

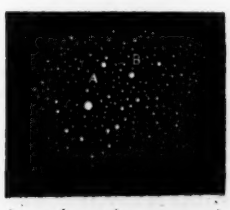


Fig. 1.—A star-group.

Fig. 2.—Imagined—but impossible—shape of a star cluster like that in Fig. 1.

Your father had no such analogy to guide him; but he was, I believe, so steadily progressing towards a change of view respecting stellar distribution (I judge from some of his later papers) that I think he might soon have been able to reverse the analogy, and *infer* the existence of multitudes of minute bodies within the solar system from the analogy which the sidereal scheme presents.

Lastly I should have referred to the question of the extinction of light. It seems to me to have escaped notice that the arguments in favour of the extinction of light and those against it are equally irresistible on the accepted theories of stellar distribution.* The *argument* on which Struve founded his formula—brightness of a star $= \frac{1}{(\text{dist})^2} (0{\cdot}990651)^{(\text{dist}-1)}$—has never, I believe, been disposed of; though arguments of equal force have disposed effectually of his extinction *theory*. Now I think that when irresistible arguments can be urged, on a given hypothesis, both *for* and *against* a certain theory, we may reasonably assume that there is something wrong about the given hypothesis.

You disposed of Struve so completely, for instance, that I believe every one has since looked on the theory of extinction as exploded; yet it was rather by arraying stronger arguments than his than by destroying the force of what he had put forward that this was done. *You* put the matter directly on this footing; but others who have quoted the result have quite forgotten that a difficulty was admittedly left unaccounted for. (I am not referring to Struve's misinterpretation of some words of your father's, but to his argument drawn from the insufficient number of faint stars.)

According to the views I have been led to form the question of the extinction of light seems an open one—but several facts seem to suggest that there *is* appreciable extinction even within such a distance as separates α Centauri from us.

I think on a reconsideration of my views you will see that (according to them) increase of distance would not necessarily lead to nebulous light. It seems to me that neither does the presence of irresolvable nebulous light necessarily indicate extreme distance, nor the converse. If we have a certain group of stars, and that group be supposed to move continually away, the question whether it will ever become nebulous (with *any* power if there be no extinction, or with a given power if there be extinction) depends wholly on the relation between the size of the component stars and the distances which separate them. If the two stars A and B, in the cluster shown in Fig. 1, are of such size and so distant that when just disappearing to the naked eye they are clear of each other in appearance, they will be equally so when just disappearing for any power whatever, unless there is extinction.

We know there are parts of the Milky Way where there is irresolvable nebulosity: and the question at once suggests itself, Have we any evidence whether this is to be looked upon as a proof of indefinitely vast extension of the galaxy in direction of the nebulosity? It seems to me that we have positive proof that this is *not* the case. I will take the case of the clustering aggregation in Perseus. Your father's account of this spot shows that

association with the Milky Way, we get the following three columns:—

I.	II.	III.
Clusters.	Planetary and Irregular Nebulæ.	Clusters.
Irresolvable Nebulæ.	Irresolvable Nebulæ.	Planetary and Irregular Nebulæ.
Planetary and Irregular Nebulæ.	Clusters.	Irresolvable Nebulæ.

Mr. Huggins's discovery (confirmed by Lieut. Herschel's observations) that the gaseous nebulæ show a faint continuous spectrum as well as the bright-line one; and Lieut. Herschel's discovery of the converse fact that stellar nebulæ show a bright-line spectrum as well as the continuous one, make tables I. and II. highly significant.

* When I speak of accepted views I refer to those which are continually described in treatises on astronomy as the direct fruits of your father's researches and your own: I know well that there is not a single line either of your own or your father's writing in which the question of stellar distribution is spoken of as one on which we are in a position to form a definite theory.

every accession of power is followed by the resolution of more and more of the spot, but that the highest powers fail to resolve some parts. Also the spot contains stars of the seventh magnitude. If then we are to look on irresolvability with given powers as a test of distance, the true figure of the system which appears to us as a spot is a frustum of a cone—as A B D C, Fig. 2—having the sun, S, at its vertex. And from the size of the largest telescope used by your father (irresolvability under which implied, he considered, a distance which light would take 20,000 years in travelling) we should have A B at least 100 times greater than C D. This seems utterly contrary to all reasonable probability; and I think we have precisely the same sort of argument here which you have drawn from the Magellanic Clouds—the conclusion being, that within limits of distance which are as about seventy to seventy-one (remembering the small area of the spot in Perseus) there may coexist stellar arrangements resulting in all degrees of resolvability, from star groups almost resolvable by the naked eye down to absolute irresolvability in the largest telescopes man has yet constructed. Irresolvability being thus shown to be no test of distance, it seems to follow, *e converso*, that absence of nebulous light under given powers is no proof of relative nearness.

If the gap in Ophiuchus is really due to distance, however, there are certainly some indications we might look for along the fading extremities of the two arms which here extend towards each other. One is as you point out the diminution of star-magnitude; but it is to be noticed that all we could look for is the absence of stars of the brighter telescopic orders. The background of this part of the Milky Way would not differ from the background elsewhere. There would be stars of all orders from those just visible up to a certain magnitude—elsewhere there would be stars of all orders from those just visible up to a certain higher order of magnitude. The difference could only be determined by careful and systematic observation directed to that special end. If there is no such difference my notion about the Milky Way would have to be abandoned, or at least looked on as not probably correct.

You will notice that my theory indicates the possibility that an infinite variety of constitution may exist in different parts of the Milky Way.

I am not sure that one could expect the Milky Way near Crux and thence to Argo to present any obvious signs of the structure I suggest—supposing my suggestion correct. The apparent difference between the nearer and farther streams would be very slight. Even in our own neighbourhood questions of relative distance are so difficult to determine, that one might expect this one to defeat any save the most systematic inquiry, directed to the special purpose of determining whether there are any signs to guide us here. I am perplexed by the appearance given to the Milky Way in this neighbourhood in the large maps of the S. D. U. K. The rest of the Milky Way is shaded to a uniform tint, and is obviously incorrect in many places. But in the south-polar map the artist has suddenly indulged in the strangest variations of shade. What authority he had, if any, is not stated. One cannot help feeling he must have had some—perhaps notes by Lacaille or others. *Inter alia*, the Milky Way is shaded much more darkly along one side of the Coal-sack than along the other; and presents in an exaggerated form all the appearances my theory would lead one to expect. Whether some southern traveller noticed a slight difference of brilliancy, which has somehow been expanded into the singular arrangement I have mentioned, or whether the whole matter is the result of carelessness I cannot say: but one actually seems to see one stream crossing the other. This I noticed after my theory was formed, so that I was naturally rather interested in the peculiarity: but if there *is* any such difference of brilliancy it must be very slight. Would it be possible that such a feature could have escaped your notice? You remember Faraday used to say when an experiment was to be shown him "What am I to *look for?*" And it seems just possible that not having the thought of looking for such a feature or of attaching any importance to it if seen, it might have escaped even your unrivalled powers of observation. I put forward this view with extreme diffidence, and am quite prepared to accept your opinion as decisive as to the appearance of the Milky Way here, if you feel clear that the delicate difference in question could not have escaped you.

According to my theory, the proper motions of the stars in Crux should be larger towards the α end of the cross than towards the other. I try the experiment, though without putting very much faith in it—as the proper motions assigned to southern stars seem to require revision.

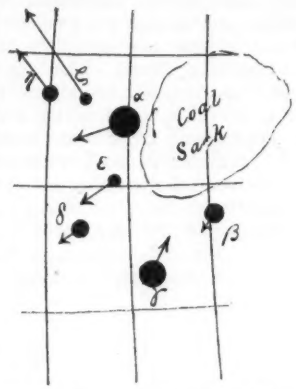


Fig. 3.—Proper motions (in 36,000 years) of stars in the Southern Cross.

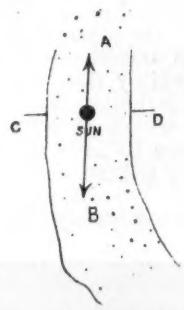


Fig. 4.—Illustrating the effects of our sun being in the midst of a stream of stars.

One cannot make much I fear from what is shown in Fig. 3. Of course it is part of my theory that the bright stars, such as those in Crux, sway the Milky Way wisps, and are mixed up with them.

I did not mean to suggest that the sun is altogether out of the plane rich in stars within which the Milky Way streams have (according to my view) been formed. But I cannot find any other interpretation of a well-defined edge *anywhere* along the Milky Way, than this, that the sun is out of that particular gathering to which the edge belongs. He might be on one part of the stream and we should still see such an edge when looking at other parts. But there is this difficulty:—If the sun is altogether out of the stream, but near its medial plane, we should see precisely the sort of increase towards the galactic plane that we actually observe, the stream only being the nuclear line (if one may speak so incorrectly) of a spiral region rich in small stars. But if the sun were *in* a stream, we ought to see an aggregation of small stars towards two opposite points on the heavens—as towards A and B (Fig. 4)—and a zone wanting in small stars towards C and D.

I am not so fond of my twisted-stream theory as not to recognise its weak points. But it seems to me we are forced to take *some* stream-theory, when we apply the laws of probability to the appearances presented by the

Milky Way. I think too that we are bound to look on the stars composing the Milky Way as really minute in comparison with Aldebaran and its like. Projecting the Milky Way to the distance due to the apparent smallness of its component stars assumed nearly equal to lucid stars, I cannot understand the many singular correspondences between its arrangement and that of the brighter stars. But looking on it as a stream swayed by the leading stars, one seems to get a general conception of its nature according satisfactorily with observed appearances.

Have you ever noticed the singular contrast between the poverty of the heavens (in lucid stars) from Centaurus to Monoceros on one side of the Milky Way, and the extreme richness from Crux to Orion on the other side? [See map on p. 89, drawn since above was in type.]

Your suggestion that the Galaxy contains within itself miniatures of itself, is very beautiful, and doubtless points to a great truth, as yet but dimly seen.—Yours very truly,

R. A. PROCTOR.

THE UNIVERSE OF STARS.

EXTRACTS FROM

LETTERS TO RICHARD A. PROCTOR.

BY SIR JOHN HERSCHEL.

Collingwood, Aug. 20, 1869.

ONE of the arguments advanced in favour of spatial extinction of light was that *if not* the whole heavens ought to be one blaze of solar light—admitting the universe to be infinite, because it was contended that there could then be no direction in space in which the visual ray would not encounter a star—*i.e.*, a sun. This argument is fallacious; for it is easy to imagine a constitution of a universe literally infinite which would allow of any amount of such directions of penetration as *not* to encounter a star:—

. Granting that it consists of systems subordinated according to the law that every higher order of bodies in it should be immensely more distant from the centre than the next inferior order, this would happen. Thus—in our own—the moon is very near the earth and the satellites to their primaries. These primaries are immensely more distant from the sun, *their* centre. The fixed stars again still more immensely more remote from the sun. Suppose *our* system to terminate with the visible fixed stars. Then imagine a system of such systems as remote from each other *in comparison with their own dimensions*, as the distance of the fixed stars in comparison with the diameter of the solar system. Such systems seen from each other would subtend no greater angle than a star seen from the sun,* and so on.

May 11, 1870.

Among the innumerable ways in which an almost infinite multitude of luminaries of all sizes and brightnesses, from [10,000 suns] down to [an ounce of red-hot stone]* may be distributed in space, so as to appear to our eyes and telescopes just as our Milky Way and sidereal firmament does, I see no distinct reason for or against a spiral, discoid, annular, or cellular arrangement. As regards the openings in the form of "Coal-sacks," I do not quite see that what you say ("Other Worlds than Ours," 1st Edition, p. 256) as to a channel having a particular direction and perfectly straight, is necessary.

Imagine, for instance, such a form (not merely plane, but tridimensional) as *this* (Fig. 5) for the star-groups and galactic masses. This would leave quite as good a passage for the visual ray out into space as the neatest cut chimney.†

Collingwood, April 1, 1870.

I have been examining my star-gauges in reference to the very curious and interesting statistical relations your letter communicates [these are given in my essay on a novel way of gauging the star-depths, "Essays on Astronomy."—R. P.]; but I see that in so far as the relation

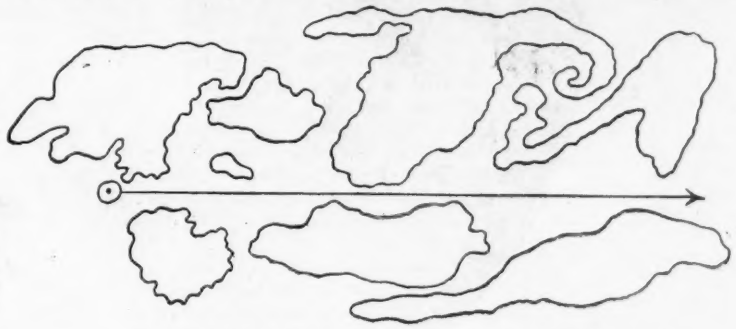


Fig. 5.—Showing how a "coal-sack" in the Milky Way may be explained.

of the grouping to the plane of the Milky Way is concerned, the results there arrived at [that is in Sir J. Herschel's star-gauges] are applicable only for stars below 8 mag., and for stars 8 mag. and upward those gauges afford no ground for any conclusion one way or other,—*i.e.*, in the mode in which they are there grouped.

It would perhaps be worth while to regroup them [be it understood that Sir John Herschel is here referring to his own gauges] for the regions within and without your boundary-line which—if I understand you right—divides the globe of stars 6 mag. and upwards into two very unequal segments—a rich and a poor one—having to each other the radii of about 5 to 2 in area, with no reference to the Milky Way, but cutting straight across it!—certainly a very startling fact, and none the less so that it should have the *Nubecula Major* for its centre. Still it seems almost too sudden to jump to a conclusion as to a real concentricity resulting from a physical connection—the more especially as the B. A. Catalogue can

* Wherefore it follows, we may note in passing, that the nebulæ which subtend much larger angles than this are utterly unlike the neighbouring galaxies as analogy would lead us to expect; hat these would appear to us—that is as mere points in apparent size, and as also exceedingly faint in apparent intrinsic lustre.—R. P.

* The brackets here are used as in mathematics. Sir John intended me to understand that each luminary might be anything from a group of 10,000 suns down to an ounce of red-hot stone. Without the first pair of brackets, I might have understood him to represent a multitude of luminaries, instead of a single luminary, by the 10,000 suns. The second pair of brackets was rendered necessary—logically—by the use of the former pair which could not be avoided. This condensed way of writing is very convenient and useful when the writer knows that his correspondent will not misunderstand him; but of course it would be very unsuitable in addressing the general public on scientific subjects.—R. P.

† The only objection is that the overlapping star-clouds would give marked variations of brightness around a "coal-sack," whereas a general uniformity is observed.—R. P.

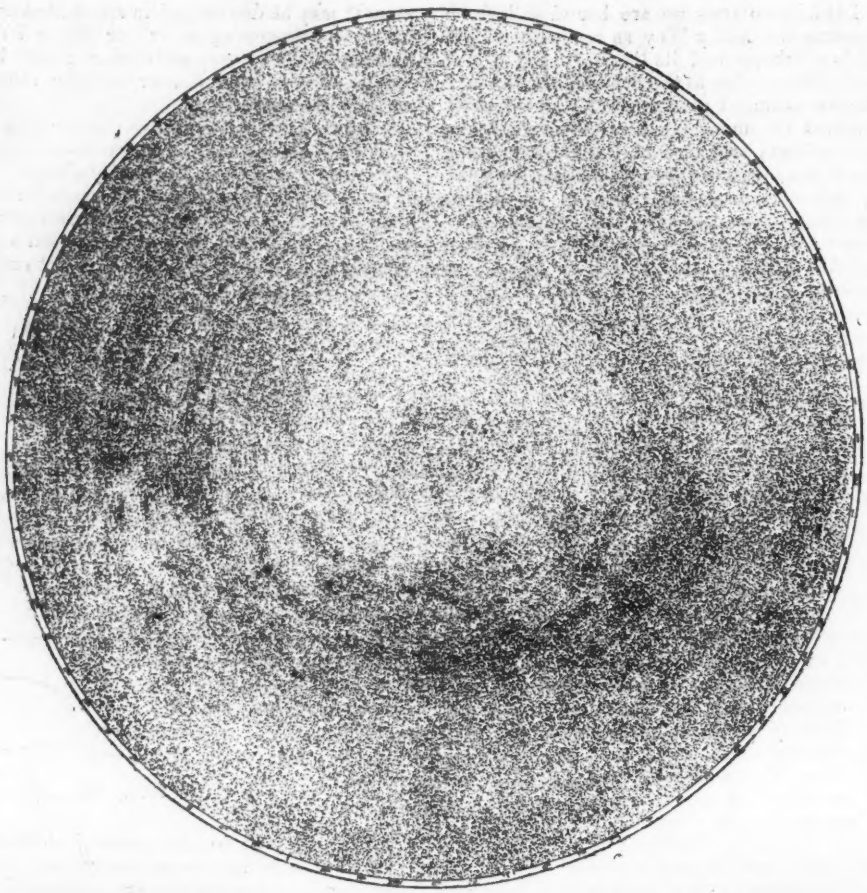


Fig. 6. Equal-Surface Chart of 324,198 Stars (from Argelander's series of 40 large charts).

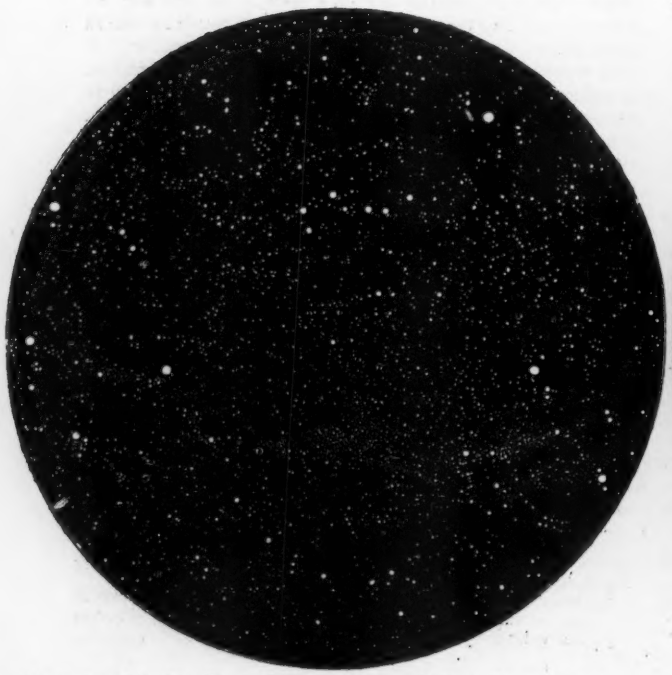


Fig. 7. Equal-Surface Chart of Northern Stars visible to the naked eye.

Fig. 8. Equal-Surface Chart of Southern Stars visible to the naked eye.

hardly yet be taken as effectively defining the limit of demarcation between 6 mag. and 7 mag.

Collingwood, July 28, 1870.

I thank you for calling my attention to that section in my "Outlines."* Undoubtedly there *is* a discordance of statements which requires correction. But the appeal there is rather to the statistical result of actual enumeration; and assuredly on a cursory view of the heavens on a clear night, stars down to the 7th and 8th magnitude *do* affect the eye, though we cannot *fix* them by reason of that strange law which curtails a star *directly* looked at of a very large aliquot part of its photometric effectiveness.

I am very glad you are taking an independent line, and utilising the immense additions which have been made to Uranography in the way of numerical accumulation and improved knowledge of proper motions, &c. We may—indeed must—form theories as we go along [what else do we observe *for?* R. P.] and they serve as guides for inquiry, or suggestions of things to inquire—but as yet we must hold them rather loosely, and for many years to come keep looking out for side-lights.

[I had submitted to Sir John Herschel my idea of a method of presenting his gauges of the southern heavens (and also, if possible, his father's) on an equal surface projection. I may remark that the idea was never carried out by myself, because Mr. Sidney Waters kindly undertook to carry it out: and placed his results, published in the Monthly Notices of the Astronomical Society, at my disposal. His valuable chart will be found in my "Universe of Stars." What prevented me from attending to that work was that I had entered on another work of a far more laborious nature, and calculated to throw much clearer light on the subject of stellar distribution in space. I refer to my equal-surface chart of the stars in Argelander's series of forty large charts. This chart, which I was not able even to begin (so few were my leisure hours) during Sir John Herschel's life, occupied me about 400 hours, which I could only with great difficulty make free out of my working time. I give a small copy of this chart as Fig. 6, an electro of which was kindly given me by M. Flammarion, in company with the two equal-surface charts of lucid stars, referred to by Sir John Herschel later on, as Figs. 7 and 8. Electros of these also were presented to me by M. Flammarion,—in consideration for the use of these illustrations—perfectly free to him however in any case—in his *Revue Mensuelle de l'Astronomie Populaire.*—R. P.]

Collingwood, July 28, 1870.

I have been thinking over plans for laying down the star-gauges, and I can light on none that seems to promise better than that which you suggest. The chief obstacle to carrying it out will, I suppose, be found in the fact that often all the gauges do not cover the whole surface, and that there are necessarily considerable areas ungauged.

July 31. I have kept this unfinished in hopes of being able to lay my hands on the mass of graphical projections, &c., which formed the groundwork of what is said about the distribution of stars in galactic parallels in my Cape observations, thinking they might save you some trouble. I know they exist, but after a great search and turning over the contents of many portfolios and boxes, I have been unable to lay hands on them—so I will not longer delay replying to your letter—and doubt not that you will quite as well accomplish your object from the registered statement of gauges—both those of my father and my own.

Collingwood, Feb. 7, 1871.

The two star-charts you have been so good as to send me (Figs. 7 and 8), are very interesting. The contrast between the star density under the arch of the Via Lactea to the right of the *Nubecula* in the southern chart as compared with that in the diametrically opposite place in the northern is striking. By the bye I miss the *Nubecula Minor* in the former. [See map on p. 89.]

* I had noticed that Sir John Herschel's recognition of a band of bright stars running nearly on the line of the Milky Way was not in accordance with his remark that stars of the higher orders are not more richly strewn in the Milky Way than elsewhere.—R. P.

EVOLUTION OF LANGUAGE.

By ADA S. BALLIN.

II.—SOUND CHANGES.

REFERRED (New Series, No. I.) to the natural selection of sounds according to individual and racial peculiarities, which is one of the chief causes of change in language. The extent of this selection may be gauged by the fact that, although, according to Prince Lucien Bonaparte, no less than 310 consonantal sounds can be articulated, even the most cultivated languages make use of but a small fraction of this number, while the less cultivated show a quite remarkable poverty. Thus, Hindustani has 48 consonants, Sanscrit 37, or, if we count the Vedic *l* and *lh*, 39; Turkish, 32; Persian, 31; Arabic, 28; Kafir (Zulu), 26 and several clicks; Hebrew, 23; English, 20; Greek, 17, of which three are compound; Latin, 17, of which one is compound; Mongolian, 17 or 18; Finnish, 11; Polynesian, 10 native consonants, of which many dialects have less. Some Australian languages have 8, with three variations. The poorest of the Melanesian group has 12, and others 13, 14, or more consonants. Looking at the chief European languages in respect to vowels as well as consonants, we find that the simple sounds in English are 40, French 35, German 28, Italian 28, Spanish 26, and Portuguese 29. The number of sounds is greatest in languages whose speakers mix largely with other nations, and almost unconsciously learn from them. The Hottentot language, however, is said to have no less than twenty simple vowels and about twelve diphthongs, but its consonants are deficient, and largely consist of gutturals. They are supplemented by four clicks—dental, palatal, cerebral, and lateral—which are apparently relics of original sounds differing little from those of the lower animals. The poverty of such languages as Latin and Greek may be attributed to the dominant character of the minds of their speakers, which forbade their adopting sounds from the races they conquered; this exclusiveness hardly exists at the present day. But, new sounds are rarely adopted into a language unless the mental and physical constitution of the race is hardy; and even when they are adopted, the sounds take on a different character in the mouths of the new speakers. The *h* in French is a German peculiarity, and the *gui* a Roman attempt to render the German *w*. Thus, *hameau* is our *home*, *guichet* our *wicket*. On the other hand, the sound of *u*, as in *pure*, arose from an attempt to pronounce the French *u* in *pure*. *Ch* and *j*, in English, are of Roman or Norman origin, but have been adapted by analogy to many words of Saxon pedigree, as *child*, Anglo-Saxon *cild*.

The Otyi-herero has neither *l*, *f*, nor *s*, *r*, nor *z*. Its pronunciation is lisping, owing to the fact that the

Vaherero have their four lower front teeth knocked out, and the upper ones partially filed away, and it is probably owing to this fact that the language possesses sounds similar to the English hard and soft *th* and *dh* sounds. The Dinka language is without sibilants, owing to similar mutilations of the teeth, and it has neither *h* nor *ch*, possessing instead *ng* and *gh*, as in Arabic. Neither the Mohawks, Senekas, Onandangos, Oneidas, Cayugas, nor Tuscaroras have any labials; and the same is true of the Hurons, in common with other American tribes. Several languages do not distinguish between *k* and *g*, and the hard sound of *g* as in *go*, and the soft sound as in *gem*, as well as *z* soft as in *zone*, although frequent in Kafir, are unknown in the Bechuana alphabet. The dialect of the Society Islands is without gutturals, and their nearest approach to the name of Captain Cook was *Tute*. Although dentals seem to be common to every language, *d* is not used in Chinese nor in several American dialects. *S* is unknown to the natives of Australia, and its place in several Polynesian languages is taken by *h*, while it is entirely absent in Rarotongan. Sanscrit has no soft sibilants, nor short *e* and *o*, Greek has neither *w* nor *f*, Latin no soft sibilants, nor hard aspirates *th*, *ph*, and *ch*, and so on. *R*, a difficult letter to individuals and nations, is never pronounced in Chinese, nor by the Hurons, Mexicans, Othomi, and other American peoples. It is absent from the Kafir language, and from several Polynesian tongues; it is most frequently represented by *l*. Thus in Chinese, Christ is Ki-li-sse-tu, while in some of the Polynesian dialects it is Kalaisi.

In many cases it seems to be the fault of hearing, which is not sufficiently fine to discriminate between certain sounds, and thus leads to difficulties in pronunciation. Thus, according to Mr. A. J. Ellis, Sir John Herschel heard the same vowel in *spurt*, *assert*, *bird*, *virtue*, *dove*, *oven*, *double*, *blood*; but I hear a very different sound in the first four to the sound of the second four, and thus divide them into two groups. On the other hand, Sheridan and Smart distinguished between the vowels in *bird* and *work*, and in *whirl'd* and *world*, whereas I hear the same vowel in all four words, unless they are pronounced by Scotch people. Webster apparently did not distinguish between the sounds *tl* and *cl*, and *gl* and *dl* in English; for he says in his dictionary *clear* and *clean* are pronounced *tlear* and *tlean*; *glory* as *dlory*. Similarly in the Sandwich Islands, *k* and *t* seem to be confused. For the same word that Protestant missionaries will write with a *k*, the French missionaries will spell with a *t*. The Hawaian does not distinguish between *k* and *t*, *k* and *g*, *g* and *d*, *t* and *d*, *p* and *b*, *l* and *r*, and the word which in one of its dialects is *koki*, in others is *hoi*, *kela*, *tea*. In Hawaian the English word *steel* becomes *kila*. As an instance of the omission of *r* and the interchange of *g* and *d* I have heard children say *keggy* for *cradle*. In such cases it is possible that both the hearing and the vocal organs are at fault, and the same may be true of a personal instance I can quote. My eldest sister informs me that when I was about seventeen months old she tried to teach me to sing these lines:—

Farmer went to market,
Up-a-gee-whoa! up-a-gee-whoa!

But the nearest approach I could make to this important phrase was,

Mangy, mangy, mangy,
Ubbababo, Ubbababo,

the "ng" being pronounced as a soft nasal. Thus the rhythm and some of the vowel sounds were caught and reproduced; but the consonants were beyond me.

The letter *f* does not exist either in Sanscrit or in the less-cultivated Finnish, and many English children find it difficult to pronounce; my brother, when a little boy, substituted *th* for *f*, as, *thilthy* for *filthy*, and apparently he could not hear the difference between the two sounds, for he always stoutly maintained that he pronounced these words rightly; so much so, indeed, that our first and almost our only quarrels were on this point. Children also frequently substitute *t* for *k*, and also for *f*, as *tat* and *titten* for cat and kitten, *toottie* for *foot*, in which example we also see the tendency common to many languages to make words end with a vowel.

In various Japanese, American, and African dialects *l* does not exist; nor is it found in the Cuneiform inscriptions, nor in Zend. It is represented by *r*, *n*, and even *d*, as German *kind*, Anglo-Saxon *cild*, English *mill*, from the Sanscrit *mar*, to rub. Children sometimes say *grass*, *ritten*, *dound*, for *glass*, *little*, *round*, and such individual peculiarities of pronunciation are legion. Conversely from the example given above, *th* is frequently changed into *f* by children and vulgarly, as *nuffin* for *nothing*. Children not only frequently end their words with added vowels, but they also insert vowels between two consonants, similarly a Hawaian would pronounce *cab*, *caba*; and Appleyard* gives the following Kafir adaptations of English words—*bapitizesha*, to baptise; *igolide*, gold; *inkamela*, camel; *ibere*, bear; *umperisite*, priest; *ikerike*, kirk; *umposile*, apostle; *isugile*, sugar; *ama-Ngezi*, English.

The tendency to which I have just referred to make no distinction between such sounds as *k* and *t* has led Prof. Max Müller† to make the following remarks, which are of great interest from a philological point of view. He says:—

> If colonies started to-morrow from the Hawaian Islands, what took place thousands of years ago when the Hindus, Greeks, and Romans left their common home, would take place again. One colony would elaborate the indistinct, half-guttural, half-dental articulation of their ancestors into a pure guttural; another into a pure dental; a third into a labial . . . . without attenuating circumstances, I cannot conceive of a real *k* degenerating into *t*, or *t* into *p*. I can conceive different definite sounds arising out of one indefinite sound, and those who have visited the Polynesian Islands describe the fact as taking place at the present day.

These remarks form a natural introduction to the explanation of Grimm's Law. The phonetic law, which Prof. Max Müller was the first to call Grimm's Law, applies to nearly the whole consonantal structure of the Aryan languages. There are three chief points of contact of vocal organs which produce consonants—the guttural *k*, the dental *t*, and the labial *p*. Each of these may be uttered hard with explosive force, *k*, *t*, *p*, or softly *g*, *d*, *b*, and are liable in certain languages to be aspirated, as in Sanskrit, where the system is complete, and we have *kh*, *th*, *ph*, *gh*, *dh*, *bh*. In old Greek the hard aspirated checks χ, δ (*th* as in both), and φ existed, but in later Greek they dwindled down to *gh*, *dh*, *bh*, which do not require so great an effort in pronunciation. In Latin there are no real aspirates, their places having been taken by the corresponding breathings *h* and *f*. Grimm's Law is a statement of the fact that—1. If the same roots or words exist in Sanskrit, Greek, Latin, Celtic, Slavonic, Lithuanian, Gothic, and High-German, then wherever the Hindus and Greeks pronounced an aspirate, the Goths and Low Germans generally, the Saxons, Anglo-Saxons, Frisians,

* "Kafir Language," p. 89.

† "Lectures on the Science of Language," ed. 1871, Vol. II. pp. 199-200.

&c., pronounce the corresponding soft check, the old High-Germans the corresponding hard check. 2. If in Greek, Latin, Sanskrit, Lithuanian, Slavonic, and Celtic, we find a soft check, then we find a corresponding hard check in Gothic, a corresponding breath in Old High-German. 3. When the six languages named above show a hard consonant, then Gothic shows the corresponding breath, Old High-German the corresponding soft check. In Old High-German, however, the law only applies to dentals, *h* and *f* generally appearing in documents instead of the soft consonants *g* and *b*. The following table* clearly shows the changes which take place under Grimm's Law, and I reprint it not only because it is one of the best illustrations of how words may be altered by change in the uttered sounds, but also because the law is so often referred to in various works, that it is useful to know exactly what it is.

	1.	2.	3.	4.	5.	6.	7.	8.	9.
Sanskrit	gh (h)	dh (h)	bh(h)	g	d	b	k	t	p
Greek	ch	th	ph	g	d	b	k	t	p
Latin	hf(gv)	f (d b)	f (b)	g	d	b	c qu	t	p
Old Irish	g	d	b	g	d	b?	c (ch)	t (th)	(p) ?
Old Slavonic	g z	d	b	g z	d	b	k	t	p
Lithuanian	g z	d	b	g z	d	b	k	t	p
Gothic	g	d	b	k	t	(p) ?	h g (f)	th d	f b
Old High-German	k	t	p	ch	z z	f ph	h g k	d	f b

Thus, 1, *garden*, Gothic *gards*, Latin *hortus*, Greek *chórtos;* 2, *deer*, Anglo-Saxon *deor*, Gothic *dius*, Greek *thēr* or *phēr*, Latin *fera*, Old High-German *tior;* 3, *beech*, Old High-German *puocha*, Gothic *boka*, Latin *fagus*, Greek *phēgós* (meaning oak); 4, *corn*, Old High-German *chorn*, Gothic *kaurn*, Lithuanian *girnis*, Slavonic *zr'no*, Latin *granum*, Sanskrit *girna* (meaning *ground down*); 5, *timber*, Gothic *timr* or *timbr*, from which *timrjan* to build, German *zimmer* a room, Latin *domus* house, Greek *dómos* house, *démein* to build, Sanskrit *dama* a room; 6, few Saxon words begin with *p*, and no Gothic words, unless foreign importations. In Sanskrit, also, *b*, which ought to correspond to Gothic *p*, is seldom an initial sound, being replaced by the labial breathing *v;* 7, *heart*, German *herz*, Old High-German *herza*, Gothic *hairto*, Latin *cor*, Greek *kardia;* 8, *three*, High-German *drei*, Gothic *thrais*, Latin *tres*, Greek *treis*, Sanskrit *trayas;* 9, *fare*, as in *welfare*, German *wohlfahrt*, Greek *póros*, a passage.

"Sound etymology," as Max Müller has epigrammatically remarked, "has nothing to do with sound," and the following rules laid down by him should never be forgotten in an inquiry such as the present:—

1, The same word takes different forms in different languages; 2, The same word takes different forms in the same language; 3, Different words take the same form in different languages; 4, Different words take the same form in the same language. The time has gone by for etymologies based purely on analogies of sound, such as we find, for instance, throughout Webster's magnificent dictionary, where Chaldee is stated to be the original language, and the Greek *para* and English *over* are connected with Hebrew *ngabar*, to pass over; Greek *agathos*, English *good*, &c., with Arabic *gada*, to be useful, profitable; English *like*, German *gleich* with Hebrew *hhalak* and Arabic *hhalaka*, to be smooth; and so on. The study of Sanskrit and the consequent discovery of Grimm's Law put an end to this kind of loose etymological guesses, and placed the science of language upon a firm foundation. We can now trace the unity of words through great diversity of sounds, and we can do this to such an extent that some writers have maintained that all the words in all the Indo-European languages can be traced back to as few as nine original roots—a subject to which I shall refer hereafter. To see how far words may differ from their originals, look at our word *lord*, from Anglo-Saxon *hlaford*, *sexton* and *sacristan*, French *sacristain*, from the Latin *sacristanus;* *bishop* and French *évêque* from Latin *episcopus*. Endless other examples might be quoted, but I have said enough to illustrate the power of phonetic decay in changing the form and sound of words.

Among the various causes to which such changes in language may be attributed, two of distinctly opposite natures are found to be preëminent:—1. Economy of effort, by which the mass of the people conveys its thoughts in the easiest possible way. 2. Elaborate expression with extreme distinctness of utterance, necessary to great orators and philosophers as a means of leading the masses, and conveying to their hearers in not-to-be-mistaken phrases the ideas they wish to disseminate. By economy of effort difficult sounds are slurred over and dropped, the ends of words are chipped off, and sentences are left incomplete when it is apparent that they are understood; hence changes of this sort are especially liable to occur in families where the intercourse between the different members is constant, and thoughts are understood almost before they are expressed. The same thing, on a larger scale, takes place in the formation of dialects. The great object of language is to be understood, and so long as words are understood they may be pronounced in as slovenly a way as is convenient. We individuals are conscious that we speak in a different way to our own families to what we do in society. When we go entirely amongst strangers we use greater effort in order to be distinct in speaking, for if we addressed them as we do those with whom we are in constant intercourse, we should probably fail to be understood. This point becomes still more apparent if we have to address a large concourse of people. Our audience necessarily consists of a crowd of minds whose range of ideas and whose vocabularies differ greatly from our own, and it becomes necessary to make considerable effort in order that they shall understand every word we utter. Our words are, therefore, carefully chosen and emphasised, and every consonant is distinctly articulated. Thus, the necessity of being understood by those who are not in intimate communion with the individual speakers acts as a kind of break on that phonetic decay which takes place on the principle of economy of effort. These two apparently contradictory principles become reconciled by the great power of imitation, the mass being raised thereby to approach the level of the orators who lead them, while the orators themselves are not entirely free from the power of the principle of least effort, which influences even them, since much of their time is necessarily spent in familiar intercourse with their kindred.

Interesting and instructive as is the study of phonetic changes, it is far distanced in importance from a psychological point of view by the study of the changes of the sense of words. We have so far dealt with the purely anatomical evolution of language, but I hope in my next to discuss its intellectual growth, for in the changes of the meanings of words we find the history of the mental development of their speakers. We shall see how great things come from small beginnings, and how the noble abstractions of science have grown up from the gropings

* Taken from Müller's "Lectures on the Science of Language," vol. II., Lect. V., which see for further information on this subject.

XUM

of the savages who first sought to use the senses with which nature had endowed them, and to embody the images so gained in signs and sounds, in order to share them with each other.

THE SOUTHERN SKIES FOR JANUARY.

By Richard A. Proctor.

TO begin with, I must explain that the map illustrating the Southern skies in January is merely tentative. I have included in it all the stars down to the fourth magnitude, inclusive; but I think the map is thus made too crowded, and that the series would be improved by excluding all fourth magnitude stars, except here and there some which complete well-known star groupings. Then as regards the delineation of stars and lettering:—I had decided to let professional draughtsmen prepare the charts from my drawings; but a careful examination of the present map has changed my opinion. My delineation and especially my lettering may be inferior to the work of professional draughtsmen in regard to *technique*, but for the purposes I have in view in such maps as these, my own work is I think on the whole better.* Again I have decided to use numbers hereafter for the southern constellations as I did for the northern. Any one who wants to learn the constellations can surely be at the pains to turn from the map to the list of names, to see what each number represents, and by freeing the map from overmuch lettering the plan makes them much clearer and more effective.

The map shows the starry sky as seen in Australia, New Zealand, Tasmania, Cape Colony, &c. (anywhere between south latitudes 30° and 45°) at about nine o'clock at night in the beginning of January, and at about seven o'clock at the end of the month.

Turning to the south, we find no polar star: (Mr. Hampden says that there is no pole, but mistakes). The nearest star to the pole in our map is β *Octantis*, a fourth magnitude star. Below the pole we see the Triangle (Southern) with *Pavo* (the Peacock) on the right or west, *Musca* (the Fly) and *Crux* (the Cross). These constellations with *Apus* (the Bird of Paradise) just below the pole, *Chamæleon*, *Volans* (the Flying Fish), *Pictor* (the Painter's Easel,—oh, those dullards who made the south polar constellations!), *Dorado* the Swordfish, *Reticulum* (the Net), *Hydrus* (the Water-Snake), and *Toucan* (the Toucan), are always visible in the southern region named, being circumpolar.

High up in the south-east we see the great ship *Argo*, wrong side up with care, the stars marked *Carina* showing the Keel, *Puppis* the Poop, and *Vela* the Sails. Naturally the sea-serpent *Hydra*, is flourishing her mighty length along the horizon underneath the masts and sails of the ship.

Due east is *Canis*, the Greater Dog, high up, and on his back, the Dove, *Columba* being perched on the Dog's hind feet.

In the north-east we see *Orion* on his head, but he makes nearly as fine a figure if his shoulder stars for our hemisphere are made leg stars for the Southern, and *vice versâ*. *Gemini*, the Twins, stand also on their heads, and by no means suggest the idea of Twins.

Taurus is the chief constellation towards the north at this time, just as from our hemisphere he is the chief constellation towards the south. Of course, it will be understood that the movement of Orion, Taurus, and all these other constellations in the northern skies of the Southern hemisphere, is from east to west, or from right to left.

Overhead, the winding streams of the river *Eridanus* extend from near β of Orion to between *Phœnix* and *Hydrus*, where the bright *Achernar* (α Eridani) is seen—a star now too far south to be seen from those places in the northern hemisphere where it used to be seen in the time when it received its name.

In the south-west quarter of the sky we see the Northern Triangle, *Aries* (the Ram), *Pisces* (the Fishes), *Cetus*, the Sea Monster, and *Aquarius*, the Water Bearer.

It would be idle to describe more fully the indications of a map which is only experimental, and not altogether a success, to my mind.

* The pairs of southern and northern maps which have already appeared in monthly Knowledge for November and December will enable the student to decide whether my mapping or the professional's is better for the purpose of these charts. The northern map in each case (that towards the right) is his, the southern map is mine. Of course my lettering, &c., may be very obviously the work of the amateur draughtsman, yet it serves its purpose; and I think I have managed to bring out the star groupings more clearly. Unfortunately the "process" by which the blocks are made is very unequal in its work—occasionally showing all the sharpness of the originals, but too often giving woolly and otherwise imperfect results.

INDIAN MYTHS.

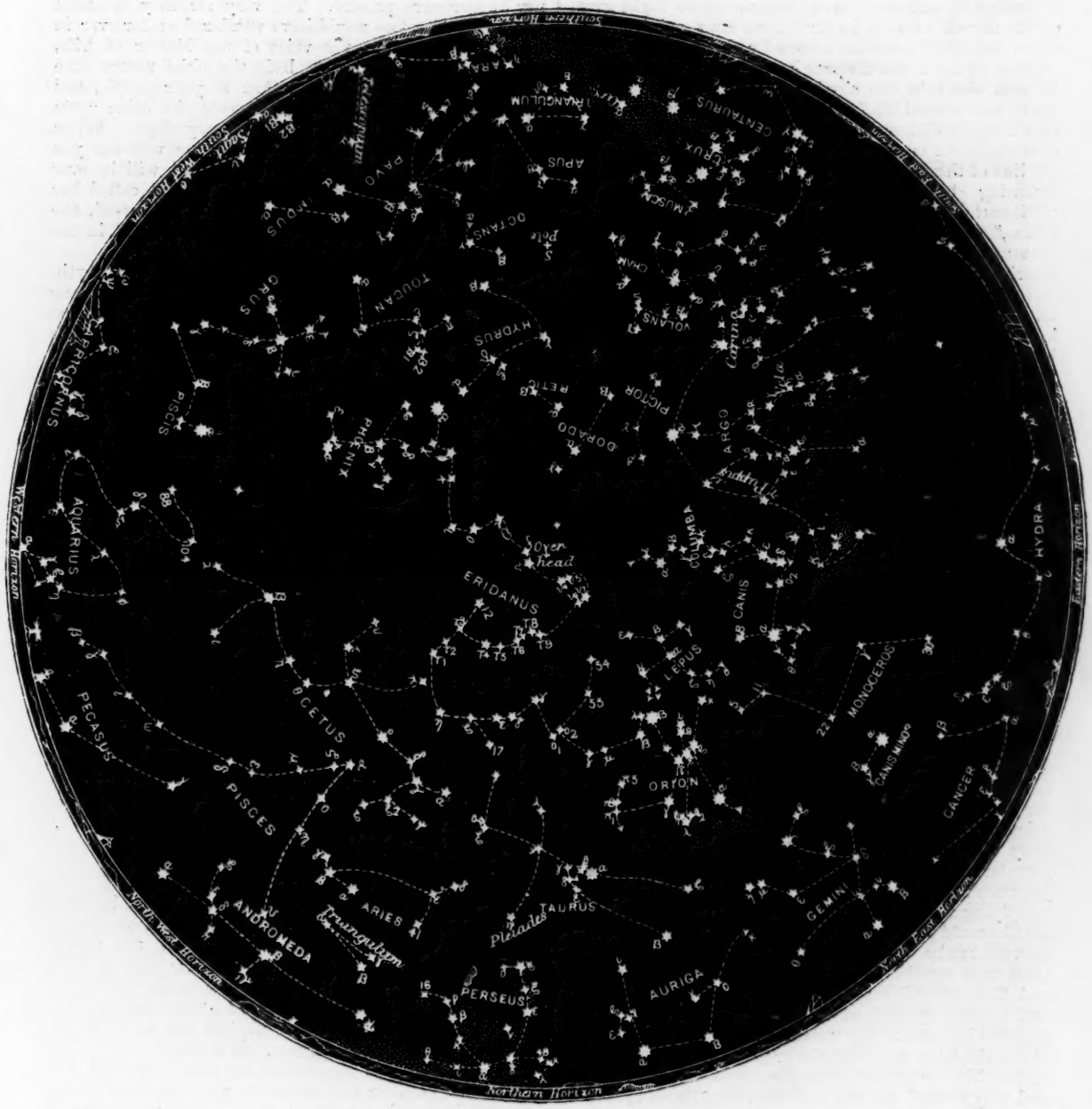
By "Stella Occidens."

Most beloved by Hiawatha
Was the gentle Chibiabos,
He the best of all musicians,
He the sweetest of all singers.
. . . . . .
All the hearts of men were softened
By the pathos of his music,
For he sang of peace and freedom;
Sang of beauty, love, and longing;
Sang of death, of life undying
In the Islands of the Blessed,
In the kingdom of Ponemah,
In the land of the Hereafter.

THERE is an old saying, that one half of the world knows not how the other half lives. For instance, it is generally supposed that the North American Indian is but a wild, untutored savage, differentiated from other savages only by his wigwam and his wampum, his war-paint and his tomahawk. In reality, he has thoughts and feelings of his own, and, above all, originality in his manner of expressing them. Mrs. Eastman, who lived seven years among the Sioux Indians, writes* that "The war-song, death-song, the song of victory, the cradle-chant, the lament for the slain—these are the overflowings of the essential poetry of their untaught souls. Their eloquence is proverbially soaring and figurative; and, in spite of all that renders gross and mechanical their ordinary mode of marrying and giving in marriage, instances are not rare among them of love as true, as fiery, and as fatal, as that of the most exalted hero of romance. Their legends embody poetic fancy of the highest and most adventurous flight; their religious ceremonies refer to things unseen with a directness which shows how bold and vivid are the conceptions of the imaginative."

The Indian has not much depth of thought, it is true. If anything puzzles him, he does not trouble himself to

* Mrs. Eastman's "Legends of the Sioux."



THE SOUTHERN SKIES IN JANUARY.

solve the problem. His mind is like a child's, which, not having as yet the power of sustained thought, easily wearies. If asked too many questions, he will answer at random. Sir John Lubbock tells us that, "Though savages always have a reason, such as it is, for what they do and what they believe, their reasons are often very absurd. Moreover, the difficulty of ascertaining what is passing in their minds is of course, much enhanced by the difficulty of communicating with them." Further on he tells us, that "Another source of error is that savages are often reluctant to contradict what is said to them."*

In this way we see how hard it is to obtain any definite knowledge of their myths and ideas generally, or to trace a clear line of thought accounting for some of the wild though beautiful legends which have descended from father to son for many generations. The Indian's knowledge is comparative, and within narrow limits is confined

* "Origin of Civilisation," p. 7.

the sum total of his belief. As he beholds day after day the wonders and beauties of nature, and at night gazes on the star-lit heavens, he must form some opinion about them, and attribute some reason for their existence. If he sees smoke in the distance he knows there is a fire, if he sees clouds in the sky he knows it is going to rain, for he has noticed that a cloudy sky precedes rain. We may imagine him gazing in wonder at the glorious stream of stars known as the Milky Way, and endeavour to trace the line of thought and observation which suggested the following beautiful story related in Schoolcraft's "Hiawatha Legends." It is called "The White Stone Canoe," and is a myth of the Dacotahs. "It is said that many years ago an Indian chief was about to be married to a beautiful girl who unfortunately died on the morning of the wedding-day. He was overcome with grief, but he was determined to see her once more. He had heard of the 'Spirits' Path,' and, hoping to see his bride again, he made a most remarkable journey. He travelled towards the south, and, at first, the hills and valleys were covered with snow. After awhile the snow disappeared, the leaves put forth their buds, and it was spring. He had left the land of ice and snow, and the dark clouds of winter had rolled by, disclosing the land of flowers and sweet singing birds, with a bright blue sky overhead. Soon he came to the path he was seeking, and it led him through a shady grove. After passing over an elevated ridge beyond the grove he reached a lodge. Here stood an old man with white hair and eyes of fiery brightness. Around his shoulders hung a robe of skins, and he leant on a staff. It was Chibiabos."*

He said to the young chief, "I have expected you, and had just risen to bid you welcome to my abode. She whom you seek passed here but a few days since, and being fatigued with her journey, rested for awhile. Enter my lodge and be seated, and I will then satisfy your inquiries, and give you directions for your journey from this point." After the chief had rested, Chibiabos gave him the following advice. "You see yonder gulf, and the wide-stretching, blue plains beyond. It leads to the land of souls. You stand upon its borders, and my lodge is the gate of entrance. But you cannot take your body along; leave it here with your bow and arrows, your bundle, and your dog; you will find them safe on your return." The chief did as he was told, and soon he was flying along the path as if he were a bird. Stranger still, he could pass through trees without any trouble, which proved that he was in the land of "shadows," and that these trees were but shadows. He saw many beautiful birds, and flowers, and everything bright and glorious. At last he came to the banks of a lake, and here he found a snow-white canoe. He untied it, and was soon paddling across the lake, when to his great joy and astonishment he saw his fair bride. She approached him in her canoe, and they crossed the lake together. The lake was covered with foam, and the turbulent waves threatened every moment to swallow them up. The travellers saw some whose boats were swamped, and as the water was wonderfully clear they could see the bodies of many who had been drowned.† The canoes in which little children travelled, however, met no waves, and they passed over in safety. After many difficulties the opposite bank was reached, and the happy pair sprang out on the land. They wandered together over the beautiful fields and meadows. Here they saw no suffering, for neither cold, nor death, nor hunger were present. The very air they breathed was food. The two would have wandered on for ever in their happiness, but the voice of the Master of Life, borne on the sighing breeze, bade the chief return once more to his native land. "Return to your people, and accomplish the duties of a good man," he said; "you will be ruler of your tribe for many days. When Chibiabos surrenders back your body he will tell you what to do. Your bride is accepted, and will be ever here, as young and happy as when I first called her from the land of snows." When this voice ceased, the chief awoke. "It was a dream, and he was still in the bitter land of snows, and hunger, and tears."*

There is something quaint and beautiful in this myth, and the fact of its being an established belief among many of the North American Indian tribes proves that dreams are accepted by them as fact. In the "Legends of the Sioux," Mrs. Eastman tells us that an old woman assured her that "the Dacotah has four souls. One wanders about the earth, and requires food; another protects the body; the third goes to the Land of Spirits (whilst sleeping); and the fourth hovers around his native village."† (The Pythagoreans give as their master's word that souls dwell in the Galaxy, and that the souls of those who are crowded there descend, and appear to men as dreams.‡) Thus they believe that everyone they see in their dreams, and everything they dream they do, are realities, but that this concerns the soul only. We read that the "Tagals of Luzon object to waking a sleeper on account of the absence of his soul."§ It would certainly be rather inconvenient for the sleeper to find himself awake without a soul. The Indian then, according to his own fancy, lives two lives, the waking and the sleeping life. Whilst he is awake he can control his own actions, but when he sleeps he believes that his soul leaves his body controlled by an unknown power, wandering far and wide, only to return when the owner awakes.‖

* The aurora; or, possibly, the rainbow.

† The story of Charon, the ferryman, is to be found not only in "Homer," but in the poetry of many lands. The River must be crossed before gaining the Isles of the Blest. "Egyptian Belief," Bonwick, p. 49.

* "Hiawatha Legends," Schoolcraft, p. 223.

† "Legends of the Sioux." Mrs. Eastman. P. 190.

‡ Tylor's "Prim. Culture," vol. i., p. 359.

§ *Ibid.*, p. 442.

‖ *Ibid.*, p. 49, vol. ii. Among the North American Indians, and especially the Algonquin tribes, accounts are not unusual of men whose spirits, travelling in dreams or in the hallucinations of extreme illness to the land of the dead, have returned to reanimate their bodies and tell what they have seen.

THE STAR OF BETHLEHEM AND A BIBLE COMET.

By Richard A. Proctor.

ONE of the strangest ways of the well-meaning but foolish persons who regard the student of science as the natural enemy of religion, is their habit of being angry with those who study the various books of the Bible for such light as these may throw on matters not specially connected with religious dogmas. Whether it is that they are in anxiety lest something not quite agreeing with their own peculiar notions about religious matters may be noted, or whether they assume that the student of science is necessarily an evil-minded person who cannot open the Bible except to find fault with it, does not appear. But they will not inquire into the historical or scientific evidence contained in the Bible themselves, and they grow exceedingly angry when any one else does.

Occasionally, however, we find them striking out both at those who do and at those who do not examine matters in the Bible which may be regarded as having a scientific or historical bearing. I have myself been personally abused in the most strenuous fashion for saying—in response too to special inquiry—that a certain description in the Bible did not (probably) relate to any known celestial body, and as earnestly rebuked for expressing my opinion that a certain description in the Bible did probably relate to a celestial phenomenon of a well-known class.

The first subject is the Star of Bethlehem. Here astronomy, following the rule of the Royal Astronomical Society—*Quicquid nitet notandum*—certainly has the right, if it is not even urged by the sense of scientific duty, to make inquiry: for here a star, observed by an astronomical race the Chaldeans (as I suppose the Magi to have been) is in question. However, here the class of persons who attribute to themselves—perhaps rather fondly—a specially religious character, have been beforehand with the student of science, and have claimed to give a scientific interpretation, or rather half-a-dozen incongrous scientific interpretations, to the record of the evangelist.

Now, we cannot overlook the fact that wherever the heavenly bodies are referred to in the Bible, they are regarded as placed in the heavens to be not only for seasons but for signs. "The stars in their courses fought against Sisera," is a saying which in old times no one misunderstood,—though nowadays some pretend to find a symbolical rather than an astrological significance in it. It is perfectly obvious that even to the very latest date covered by the books of the Bible the heavenly bodies were regarded as not only influencing and indicating, but as actually affected by, the fortunes of the human race. As the first book, nay the first chapter of the Bible, says (like the Assyrian tablets from which it was apparently derived), that the sun, moon, and stars were for signs, so the last speaks of the sun turning black as sackcloth of hair, of the moon becoming as blood, of the stars of heaven falling to the earth ("even as a fig-tree casteth her untimely figs, when she is shaken of a mighty wind") —solely because the kings of this poor little earth of ours, and the rich men, and the chief captains, and so forth, were to be discomfited. It is as absurd to try to blind oneself to these clear indications of the ideas very naturally entertained in those days respecting the sun, moon, and stars, as it is to attempt to overlook the mistaken ideas men had then formed about the shape and dimensions of the earth, the laws according to which rain, wind, storm, snow, hail, and other natural phenomena are produced, the nature of epileptic and cataleptic seizures, madness, idiocy, and a number of other matters, which men nowadays begin to understand but then knew scarcely anything about. To imagine that revelation should be of such a nature that it would make a Bacon of a Moses, a Newton of an Isaiah, a Priestley of a Luke, or a Laplace of a Matthew, is surely to mock not to reverence Deity,—at least it would be so if those who thus teach could see the utterly absurd inferences deducible from what they seem to believe.

Viewing matters as we find they actually were, it becomes a matter of considerable interest to the student of astronomy to ask whether any, and if any what heavenly body, may possibly have been referred to in the description given by the evangelist Matthew of what has been called the Star of Bethlehem. Many imagine that the star seen in 1572 was the same orb which had blazed out suddenly when Christ was born, and was regarded by his followers, afterwards, as indicating that he was the appointed "Governor that should rule God's people Israel." Some heavenly body, they say, which then appeared, is certainly referred to by Matthew: may it not have been the same which appeared in 1572? There is reason to believe that this is the same star which shone out at intervals of about 312 to 314 or 315 years before, and may shine out in 1886 or 1887—to announce, perhaps, as many imagine, the second (though according to the star it ought to be the sixth) coming of Christ. Whether this is so or not a few months now will determine. But reading Matthew's account as it stands it seems hardly likely (though it is by no means absolutely impossible) that it related to that particular orb.

The place in Cassiopeia where the star of 1572 appeared would in the beginning of the Christian era have been about 36° from the North Pole (much further away than now) and in about right ascension 22 h. 40 m. Thus at midnight in the latitude of Jerusalem, on or about Dec. 25, the star of 1572, if it had then been shining, would have been towards the north-west low down, which was not the right direction for the house in Bethlehem as probably approached from Jerusalem. Earlier the star would have been higher up, and therefore could hardly have been described as going "before them till it came and stood over where the young child was." Indeed could *any* star, or planet, or comet, be described in these terms? Manifestly (it seems to me) the evangelist meant to describe a purely supernatural phenomenon.

Yet for expressing, in response to especial inquiry, this very reasonable opinion, and rejecting as unreasonable the idea that a star hundreds of thousands of millions of miles from this earth, blazing out at tolerably regular intervals of 314 years, on account probably of some peculiarity in the movements of cometic and meteoric matter around it, had been as it were waited for in this case (instead of being made to wait upon the coming of the child, as the whole spirit of the evangelist's narrative implies) I have been rebuked as if possessed by a spirit of intensest hostility to religion itself.

This is absurd enough; but the absurdity becomes more intense when coupled with a converse absurdity of an equally ridiculous sort.

There is a passage in the history of David which seems to me to have a manifestly astronomical interpretation, and indeed—while perfectly in accordance (as so understood) with what we know of the ideas of the ancient Hebrews about such matters—to help to explain a very remarkable feature of all the books of the Bible.

The comet, most impressive and awe-inspiring of all heavenly bodies, is nowhere mentioned in the Bible—full though its pages are of passages showing how the Hebrews were impressed by the wonders of the star-depths. This is so remarkable that we are naturally led to inquire whether under some other name comets may not be referred to in the Bible. It seems likely on *à priori* grounds that the Hebrews would regard comets, even more confidently than other less impressionable races did, as special messengers from God. And as Hebrew writers did not hesitate to express their opinions on such points, confidently saying, for example, that the heavenly bodies were for signs, that the stars in their courses influenced the fortunes of a third-rate chief, and so forth, they certainly would have described comets as celestial messengers if they thought them so.

Thus led, we examine passages where they actually speak of celestial messengers, finding, to begin with, that the word they used for such beings actually meant a

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heavenly body, an appearance in the heavens, a celestial apparition—and so would apply as well to a comet as to what we (not knowing much perhaps of the real significance of the old Hebrew word) translate as "an angel" and picture as a being clothed in stuffs of apparently human manufacture. Nor assuredly if a Hebrew writer regarded a star, planet, or comet, as a messenger from God, would he hesitate, when calling it an angel, to characterise it as an Angel of the Lord, for so certainly it would appear to him.

Now there are several passages where an angel or celestial messenger is described in terms which would apply very well to a comet; but there is one passage which, as I think, can be interpreted in no other way, without understanding a series of miracles, for which, so far as one can judge, the occasion was by no means worthy.

In the history of David we are told that having numbered the people he was informed by an ecclesiastic called Gad (who appears to have claimed to express the very thoughts and feelings of Deity—a practice not perhaps unusual with the priests attached to royal persons) that he had angered God exceedingly—though wherein the offence consisted is not clear. Be this as it may, David was left to choose between three punishments, of which he selected the one least likely to affect himself. So pestilence came "and there fell of Jerusalem seventy thousand people." So far all is perfectly natural, and doubtless historically accurate. But now suddenly an angel appears as "sent unto Jerusalem to destroy it," but bidden presently to stay his hand, and waiting,—"the angel of the Lord stood by the floor of Ornan" (elsewhere called Araunah) "the Jebusite." Gad appears to have been powerless in this emergency. Something there was which he and David and all men saw. There is no particular reason for supposing that just at that particular time in the history of that particular oriental race and of that particular (or in some respects not *very* particular) ruler, a miraculous apparition remained hovering (for how many days the account does not say, but it must have been quite a considerable time) in mid-air over Jerusalem. Yet something there was up there which terrified the people and David himself, and possibly Gad too, clearly though he claimed to see the meaning of the portent. David indeed wanted to go up to Gibeon to sacrifice before "the tabernacle of the Lord"; but he was afraid to go up that way because of the angel of the Lord, standing "between the earth and the heaven having a drawn sword in his hand stretched out over Jerusalem." (If this was not a comet, by the description, it was the personage referred to in the first verse of the self-same chapter—I. Chronicles, xxi.). David and the elders, clothed in sackcloth, fell upon their faces, as was perfectly natural—for a comet, not understood in its scientific aspect, as something to be timed, calculated, analysed with a spectroscope, and so forth, is a very terrible object indeed to look upon. Then Gad said that the celestial messenger had explained to him that David was to buy the threshing-floor of Ornan—one account says for fifty shekels of silver, but the other for six hundred shekels of gold—there to set up an altar, for sacrifice, burnt-offerings and peace-offerings, and other sacrifices such as in our days we scarcely think of offering "to the Infinite Power from whom all things proceed." Whereupon, we are told, that "the Lord commanded the angel, and he put up his sword again into the sheath thereof."

We need not smile at the simplicity of David and the elders,—possibly (let us hope) of Gad also, though the purchase of the altar has a doubtful look. For at the time of the plague and fire of London, people were equally ready to interpret the comets preceding those events as God's messengers. Defoe tells us that they saw those comets manifestly hovering over the city, nay heard the crackling of the flames proceeding from the one which forewarned the coming of the great fire. Medals were struck, and are still in existence, in which these comets are pictured with words implying that they were in truth the messengers of God's wrath. Again only a few centuries before, Pope Calixtus sent an army of Franciscan Friars "to pray against the Turks, and the comet, and other enemies of Christendom"—nay an old historian even relates that in response to their prayers the comet retreated (as it doubtless did) "the sword of God's vengeance being returned into its sheath." This was many many centuries after the time of David and Gad, whose ideas about the celestial apparition hovering between heaven and earth over Jerusalem were perfectly natural for pre-Newtonian times.

But singularly enough this attempt to give a scientific interpretation—historically and archæologically interesting as I think—to the very striking narrative in II. Samuel, xxiv., and I. Chronicles, xxi, has been received in exceedingly bad part by the same class of persons to whom the endeavour to give a scientific interpretation to the precisely parallel account of the Star of Bethlehem in Matthew ii., seems altogether laudable!

PICTURES.

By Baroness Von Gottrau.

"Die Kunst ist ein Spiegel in welchem sich die Zeit und die Welt abspiegeln."

In my article in the last number of Knowledge, I remarked that the similarity between the arts of music and painting would be interestingly apparent; and, indeed, as we have the expressions of many ideas and feelings given to us through the combination and modulation of tones, so have we the same in pictures through the wonderful combination and modulation of colours. And I also remarked that in a picture the artist could actually put before us but one certain moment of an act, or one degree of an idea or feeling; yet it will not be understood by that that I mean the art of painting is inferior to that of music.

All the polite arts are great. One artist may be much greater than another; but as art means the fair execution of noble thoughts and conceptions, it will not be said here whether it be greater to execute these thoughts and conceptions in poetry, painting, music, or in sculpture.

One artist may have a more profound or more beautiful conception of a subject than another; but, at the same time, this artist may not be able to execute his idea perfectly. For instance, he may not be able to draw well, to make a correct perspective, or, perhaps, to paint flesh with a natural hue. But all these details should be perfectly executed in order to make the *ensemble* grand and effective; for to break the laws of perspective, or correctness of colour, would be as grating upon our feelings as to hear the breaking of a rule of harmony in music.

If in a picture the artist is supposed to suggest more to our minds than he has actually put before us, this then is at any rate far more difficult than in music, where

the artist begins at the beginning, and leads us with him step by step to the end.

The highest aim in Art is to represent Nature perfectly.

For instance, if a painter will make a picture representing a storm in a forest he must first of all *feel* the grandeur and beauty of the scene, and the wonder of the workings of the elements of Nature, and then he must so exactly paint every detail of this scene that we seem even to see the swaying of the branches of the trees, feel the wind, &c.; in fact every line of drawing, and every tone of colour must be so perfectly in accordance and harmony that we forget we are only looking at a picture and feel as though we are in reality witnessing the scene.

The composer of music to illustrate this same subject must likewise feel the grandeur, beauty, and wonder of it; but then it is within his power to first describe this forest in repose, then step by step he brings on the storm; makes us hear the thunder in the distance, then it comes nearer and nearer, we feel the wind grow stronger and stronger, the lightning breaks suddenly upon us, and after holding us in the midst of the great storm, he may, if he pleases, illustrate the ceasing of it, and leave us at last in that delightful calm and freshness which always follows the storm, with all the beauties of nature in sweet repose. I have allowed myself to give this small illustration simply to show how similar is the work of the painter and composer; for it is in this manner that every subject—be it historic, romantic, practical, or sentimental, must be treated.

The composer of music conceives his subject, and then executes it by the many variations, modulations, and harmony of tones; while the painter must, in the same artistic manner, execute by the perfect lines of drawing, and the delicate and exact tones, modulation, and harmony of colour.

And so, to repeat what I have quoted at the head of this article, "Art is a mirror in which time and the world are reflected." As we hear of the time when it was not known that different tones could be put together and make harmony, so we hear of the time when the old Greeks were delighted with the idea and success of one Saurias, in drawing the line of the shadow of a horse standing in the sun; and then later, when Kore, of Corinth, drew the line of the shadow of her lover upon the wall, and it afterwards occurred to her father, who was a potter, to copy the drawing upon one of his pots.

Thus began the first illustrations in pictures, and from those quaint old drawings on vases, pots, &c., we learn of the character, customs, and ideas of the people of that time, and so on up to the present day we find in pictures, as in music, to a great extent, the history of the world and its people.

A portrait-painter has the most difficult and greatest work of all; for as the highest aim of art is to perfectly represent nature, and man has been created as the noblest and most perfect of all things, then the highest degree in art has been attained when we see a perfect portrait of any person. But we often see a painted representation of a person where the shape of each feature may be drawn very fairly; the shape of the head, nose, and mouth may be well represented, and the exact colour of the hair and eyes, but if all this appears flat and cold upon the canvas, with no soul or warmth of life in it, can it be called art? No; there must be life and soul in it; it must be *plastic*—must stand out before us in a natural, life-like manner; we must feel the softness and warmth of the flesh, must see the soul lighting the eyes, and the expression of eyes and mouth must portray the character of the person. There must be soul in it! Soul must speak to soul—the picture must speak to us!

There are at the present day amongst the Germans some excellent painters, and it will probably interest the readers of KNOWLEDGE to see in luxotype print some copies of some of the best and latest pictures of these artists.

In Gabriel Max's pictures we will have a very interesting study, for he has in the first place a profound conception of things, and places them before us in a most artistic and lifelike manner. There are not very many painters of the present day that can equal him in his delicate and natural representation of flesh; and his figures are so plastic, and he possesses such an extraordinary talent for making one see and feel the relation of one thing to another.

With the editor's permission KNOWLEDGE will give with my next article on pictures a luxotype of one of Max's pictures.

München, *December*, 1885.

THE DIGNITY OF SCIENCE.

BY RICHARD A. PROCTOR.

A CURIOUS question has been raised respecting the dignity of science in the pages of *Nature* and by the editor of *Nature*. The profane may be apt to think that not dignity so much as—perhaps—a different quality, is involved: for the idea underlying the theory of scientific dignity which Mr. Lockyer has advanced would appear to be that,—Your man of science ought to be incapable of anything so degrading as *work*, but to *beg* he should be by no means ashamed. The discussion, if such it can be called, arose as follows:—

Professor Odling, in a singularly able address delivered to the Institute of Chemistry, had dealt in a manly way with the necessity under which most men labour of earning a livelihood,—of maintaining themselves and their families. He had said—but I had better quote his own words:—

"The best of all endowments for research is unquestionably that with which the searcher, relying on his own energies, succeeds in endowing himself. The work to which our natures are repugnant, not less than the work which entrances us and hardly makes itself felt as work at all, has to be done. In some degree or other, we have most of us to obtain our own livelihood; and harsh as may seem the requirement, it will, I suppose, be conceded that the necessity put upon the mass of mankind of having to earn their daily bread is an arrangement of Providence which has on the whole worked fairly well; and further, that the various arrangements hitherto tried for exempting certain classes of men from the necessity of having to earn their daily bread, in order that they might give themselves up to the higher spiritual or intellectual life, have scarcely, to say the least of them, worked quite so satisfactorily as they were intended to. All of us are, without doubt, qualified for higher things than the mere earning of our daily bread; but the discipline of having to earn our daily bread is, in more ways than one, a very wholesome discipline for the mass of us, and even for the best of us. It may here and there press hardly on particular natures, but it is rarely an impediment to the achievement of the highest things

by those having the moral qualities, the judgment, the determination, and the self-denial necessary above everything else for their achievement. Not a few of us may consider ourselves fitted for higher work than the gods provide for us, and fondly imagine what great things we should effect if we could only have our daily bread supplied to us by the exertions and endowments of other less gifted mortals. But experience is not on the whole favourable to the view that, the conditions being provided, the expectation would be realised. Experience, indeed, rather favours the notion that it is primarily the necessity for work, and association with those under a necessity to work,—those in whom a professional spirit has been aroused, and by whom work is held in honour,—that creates and keeps up the taste and the habit of work, whereby the vague ambition to achieve is turned to some productive account. Take, say, a thousand of the most eminent men the world has produced, and making no allowance for the large influence of descent or training, or of association with those to whom work is a necessity, or having been a necessity is become a habit, consider what proportion of these men have, by their means and position in early life, been free from any stimulus or obligation to exert and cultivate their powers; and consider, on the other hand, what proportion of them have been stimulated to exertion and success by the stern necessity of having either to achieve their own careers, or to drop into insignificance, if not indeed into actual or comparative degradation and poverty. We ought, indeed, all of us to be students, and to be above all things students; but most of us cannot be, nor is it desirable, save in the case of a special few, that we should be only students. We have, all, our duties to fulfil in this world, and it is not the least of these duties to render ourselves independent of support from others, and able ourselves to afford support to those depending upon us. Fortunate are we in being able to find our means of support in the demand that exists for the applications of a science which has for its cultivators so great a charm. To judge, however, not indeed by their coyness when exposed to the occasional temptation of professional work, but rather by their observations on the career of others, the most sought after and highest in professional repute, the pursuit of professional chemistry is, in the opinion of some among us, a vocation open to the gravest of censure. It is praiseworthy, indeed, for the man of science to contribute to his means of livelihood by the dreary work of conducting examinations in elementary science for all sorts of examining boards, and by teaching elementary science at schools and colleges, and by giving popular expositions of science at public institutions, and by exchanging a minor professional appointment, affording abundant opportunities for original work, in favour of a more lucrative and exacting appointment involving duties which, if rightly fulfilled, must seriously curtail these same opportunities. It is praiseworthy of him to add to his means by compiling manuals of elementary science, and by writing attractive works on science for the delectation of general readers; but it is, forsooth, derogatory to him, if not indeed a downright prostitution of his science, that he should contribute to his means of livelihood by making his knowledge subservient to the wants of departments, corporations, and individuals, alike of great and small distinction, standing seriously in need of the special scientific services that he is able to render them."

I fear it must be admitted that the sarcasm of the last few lines was somewhat too unmistakably aimed at the editor of *Nature*, though this would not have been so obvious but for the circumstance that Professor Odling and other eminent men of science had been rebuked so bitterly by Mr. Lockyer for making their knowledge subservient to persons and corporations who had had the bad taste to overlook the superior qualifications of more —dignified—persons.

Naturally therefore much space is devoted to rebuking the better-known chemist. This is not done perhaps in the most open way. One is reminded rather of Koko's (or rather Grossmith's) suggestion of the individual representatives of Gilbert's types which "never would be missed." As Koko by tracing an invisible moustache here, an imaginary eyeglass there, and an imperceptible development of collar elsewhere, unmistakably indicates without actually naming the persons to whom the Bab-Ballader objects, so Mr. Lockyer by mentioning some of the best-known details of Prof. Odling's busy life, directs pointedly against him the rebukes which he is professedly directing against types.

These rebukes imply that such work as a man of science may do in the way of earning a living must not, even though the work assists the industries depending on science, interfere with higher work if higher work has been undertaken. What is the higher work does not very clearly appear. Is the determination of the position of a few lines in the solar spectrum high work? and is the application of the spectroscope to the improvement of metallurgical processes low work? Would a Dr. Huggins studying the lines of iron in the solar spectrum be an altogether dignified person compared with a Bessemer studying spectra in his iron-works? and what position would then be assigned to a third person—Mr. Lockyer, for instance—who should patent for his personal benefit a process which he thought likely to be useful to metallurgists?

For my own part I find such discussions as these, at least from Mr. Lockyer's standpoint, altogether wanting in dignity. I hold with Professor Huxley that a man of science should regard himself as a citizen in the first place, a student of science in the second (if in so high a place). Whether a man who deems himself capable of enlightening the world but is unwilling first to maintain himself and his family, acts like Palissy, letting wife and children want and run the risk of actually starving while he throws the last stakes in his gambling venture for fame and wealth, or whether he sickens his fellows by begging unceasingly for State alms, he equally—in my judgment—degrades research, if he does not disgrace manhood. I think far better of the man who like Mr. Lockyer, as pictured without being named by Professor Odling, and Professor Odling, as pictured without being named by Mr. Lockyer, earns money for himself and his family by work in which scientific progress in one form or another is held in view.

Of course we can sympathise with those who believe that they could do more useful work were they not thus obliged to give so much time to the higher duties of the citizen, the husband, the father; and we may rightly feel wroth with men who, having ample means and perhaps no family dependent on them, leave their powers unused (as, alas, Newton did from the time when a well-paid post was given him). But men sometimes misjudge their powers, and are really doing more good in what seems to them inferior work than they could have done (to say nothing about what they would have done) if freed for higher researches. And as to the balance between the sense of duty in regard to research on the one hand and in regard to family on the other, there should be no question. The student of science who, as years

advance, looks back at his own career, is more apt—if he is conscientious at all—to feel the reproach of conscience for time given to advance scientific knowledge which should have been devoted to his family, than for labours directed to the well-being of his family when he might have been advancing scientific knowledge. And this point of conscience really settles the question of dignity; for a course can never be consistent with dignity which is contrary to the dictates of conscience.

OPTICAL RECREATIONS.

BY A FELLOW OF THE ROYAL ASTRONOMICAL SOCIETY.

COLOUR AND LIGHT.

IN speaking of the ultimate constitution of white light on pp. 48 and 49, we said that in decomposing a beam of solar light by the aid of a prism into five distinct bands of colour, we had "not even yet reduced our spectrum to its lowest terms." Let us endeavour to ascertain how much farther we can simplify it.

Every possessor of a paint-box knows how very few paints are really needed to represent—at all events approximately—the majority of colours we meet with in nature. Suppose, for example, that we are restricted to carmine, Indian yellow, and Prussian blue. The carmine and the Indian yellow, mixed in various proportions, will give us a series of oranges and orange-reds; the Indian yellow and the Prussian blue a large range of greens; while all sorts of violet and purple hues are obtainable from varying mixtures of Prussian blue and carmine. This, the employment of an impure spectrum, *i.e.*, one mixed with white light, and some misunderstood experiments with absorptive coloured media, induced Sir David Brewster to propound the theory in his work on "Optics" in "Lardner's Cabinet Cyclopædia" (pp. 72 *et seq.*), that white light has in reality but three primary constituents—red, yellow, and blue. He announced this in the work just cited as an original and independent discovery; but he had been long anticipated in his doctrine of the triune character of light, first by Wünsch at Leipzig in 1792, and not long subsequently, at the beginning of the present century, by that truly great philosopher and physicist Thomas Young, in this country. Nay more: so far from Brewster having made a discovery, he absolutely enunciated an erroneous doctrine, and took a retrograde step in comparison with those of his predecessors. It is quite true that the light of the sun, as it reaches us, is compounded of three colours, and of three only; but unfortunately two out of Brewster's three colours happen to be the wrong ones! For while it is the veriest truism to assert that blue and yellow *paint* mixed together form green, no such result can be predicated of the mixture of blue and yellow light; which mixture, so far from being green, is white. These colours are, in fact, complementary to each other. Helmholtz has explained how it is that blue and yellow pigments produce green by admixture. If we make solutions of, say, Prussian blue and gamboge, we do not obtain a pure blue, or a pure yellow. In the former case a quantity of green light gets through with the blue; as in point of fact, it does with the yellow light too. Then supposing that we mix such a blue and yellow as this, the blue will cut off the yellow, the orange, and the red end of the spectrum; and the yellow will similarly obliterate the blue, indigo, and violet end. We have seen, though, that both are transparent to green, so that when white light passes through a mixture of blue and yellow paint, or through superposed blue and yellow glass, the green alone reaches the eye. Furthermore, if we carefully select colours of the proper degree of refrangibility, and paint discs with them, causing the light reflected from these discs (by a contrivance to be immediately adverted to) to reach the eye simultaneously, by no artifice whatever shall we succeed in producing a green hue, or, in fact, anything but a greyish white. The fact is, as we shall see by and bye, that the three primitive colours are a scarlet red, emerald green, and violet blue, or blue violet.

For the purpose of compounding coloured lights, what are known as "Maxwell's discs" (from their inventor, the late lamented Clerk-Maxwell) afford considerable facilities. They are simply circular discs of white cardboard, as

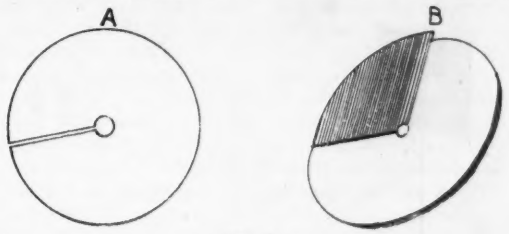


Fig. 6.

shown in Fig. 6, A, each furnished with a radial slit which enables two or more of them, each being painted of the required colour, to be superposed on the spindle of an ordinary whirling table. B in the figure shows two of these discs as being partly superposed. A glance at the figure—or, better still, the cutting out of two such discs, will show how the proportion of any given colour to any other can be obtained by simply twisting one of the discs round its own centre. The whirling table scarcely demands description here; but we may mention that the one employed by ourselves for the purposes of this series of papers consists of a base-board 36 inches long, 8 inches wide, and $\frac{5}{8}$ inch thick, at one end of which a grooved wheel 9 inches in diameter rotates on a vertical spindle, and, by the aid of a piece of fine cord, drives another small vertical spindle at the other end of the board, the last-named one carrying the discs which we have just

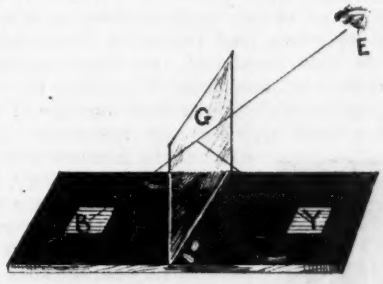


Fig. 7.

been describing. If now we paint two of these discs with chrome yellow and ultramarine, fasten them on our spindle and set them in rapid rotation, we may vary the area of blue or yellow respectively in any proportion we please, but we shall never obtain any resultant tint in the smallest degree resembling green.

Another simple piece of apparatus for mixing coloured light is shown in Fig. 7, and may be bought at any of the so-

called "novelty shops" in London. Its primary purpose is to teach drawing by enabling a child to trace on paper behind a reflected image. It is, however, equally useful for our present purpose. It consists of a thin flat base, from which rises centrally, and at right angles, a plate of glass, G. The base must be blackened with a dead black, either by pasting a piece of such paper over it, or by painting it with lampblack and size. If now we place a piece of coloured paper (say blue) at B, and another (suppose yellow) at Y; then, the eye at E will see the former directly through the glass and the latter by reflection seemingly superposed on it, in a way which our figure above will render immediately intelligible. If it be desired to vary the brightness of the image, this may be effected by moving the bits of coloured paper further apart or nearer together as the case may be.

Fig. 8.

Yet another and very effective method of mixing coloured light is shown in Fig. 8, when C is a piece of black cardboard in which two circular holes are punched with an ordinary gun-wad punch, with an interval of $\frac{1}{8}$ inch or so between their peripheries, and then are covered with thin sheets of gelatine of the required hues—let us say in this case red and green. P is a common "double image prism," purchasable of all dealers in polarising apparatus. The familiar effect of this is, of course, to duplicate all images, and so cause an apparent overlapping of the colours, the prism being rotated until superposition occurs and a sufficient area of the combined lights becomes visible. Should we chance to hit upon the two proper colours, the overlapping portion will approximate to white. We shall, though, most probably find that it will be yellowish or orange, thus definitely exploding the idea of Sir David Brewster that yellow is a simple colour. Or, again, by the aid of two magic-lanterns such as are used for dissolving views (and preferably illuminated by the electric or the lime-light), we may superpose the images of two coloured discs of gelatine upon a white screen, so as to exhibit to a large number of people at once, in a most striking and instructive form, the effect of the mixture of the primary spectral colours. Lastly, by a very simple little artifice we may mix the colours of the spectrum themselves. All we have to do is to cut two very narrow slits in a black card — or, perhaps preferably, a sheet of latten-brass—as shown in Fig. 9, and view them through a prism whose edge is parallel to their length, from a distance of a yard or so. It will easily be seen how and why the spectra will overlap. It is needless to add that the train of prisms in a "direct-vision" spectroscope exhibits this effect in a much more striking form. We would earnestly urge on the student the necessity of repeating every one of these experiments for himself. He will thus realise their import in a manner wholly unattainable from the mere perusal of our descriptions Whichever of the modes just described we adopt for combining coloured lights, we shall find that red, mixed with greenish blue, orange and a greenish blue, bright blue and bright yellow, and greenish yellow and violet light, when mixed in the pairs indicated, all four give white light as a result. In the case of Maxwell's discs, the resulting hue is always more or less grey, rather than white. The origin of this lies in the difference of luminosity of the two colours, and it is quite possible upon a few trials accurately to imitate the very pale grey furnished by (say) a pair of blue and yellow discs, by means of a properly proportioned black and white pair alone. Now it was upon researches into this elementary constitution of light that Young founded his famous theory of vision, more recently adopted and expounded by Helmholtz. He supposed that each element of the retina of the human eye (Fig. 1, p. 16) possessed the capacity for transmitting three kinds of sensations; or, to put it in another way, each element was entered by three fibrillæ of a nerve, one of which vibrated to, or was excited by, red light, the second in like manner by green light, and the third by violet light. It would be more rigidly correct to say that these fibrillæ are *principally* excited by light of the colours named, respectively; since Young conceived that what we may call the red nerve fibril is very feebly responsive to green and violet waves as well; the green fibril to red and violet waves, and the violet fibril to red and green waves; albeit the overwhelming part of their excitation proceeds from those colours alone to which each is more especially adapted. When the three sets of nerves are equally excited we experience the sensation which we call white. When the set most sensitive to the least refrangible rays is excited, we see red; when the nerves affected by the middle of the spectrum are set in motion we see green; while the nerves most susceptible to the most refrangible end of the spectrum when excited give us the sensation of blue or violet. As far as the mammalia are concerned, dissection of the eye has, so far, furnished no corroboration of this theory; but Max Schultze actually has discovered in the eyes of some birds and reptiles, among the rods of the retina many which contain a drop of red oil at the end fronting the cornea or which is turned towards the light; while other rods contain a yellow drop, and others none at all. It is not difficult to see the bearing of this on the theory of Young and Helmholtz. Now assuming this theory to be correct, let us see how it explains the production of the sensations of single colours by the mixture of two others. In the ordinary spectrum (Fig. 2, p. 16) yellow lies between green and red; hence a mixture of red light and green light ought to produce the sensation of yellow light by stimulating what we have called the red nerves and the green nerves. This may, perhaps, be most successfully effected in the modes illustrated by Figs. 8 and 9 above; but a very tolerable though somewhat dingy yellow is producible by the combination of two of Maxwell's discs (Fig. 6) coloured with emerald green and vermilion respectively, and set in rotation on the spindle of a whirling table. We have said that the resulting tint will be that of a "dingy yellow"; nor is the reason far to seek; the chrome yellow, Indian yellow, or Cadmium yellow of our paint-boxes are very much more luminous than our vermilion, carmine, emerald, or sap green, and it is obviously impossible, to use a homely form of phraseology, to get more luminosity out of a combination of coloured discs

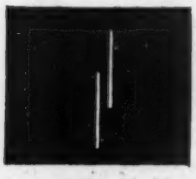


Fig. 9.

than you put into it. Pretty evidently, then, the total luminosity of the spectral coloured disc produced by rotation will be the mean of the luminosities of its two painted components. Suppose now that we diminish the intensity of our green light, then will the yellow produced by its combination with the red become orange, passing as such diminution progresses through red-orange and orange-red to pure red. It will be at once inferred that if we, on the other hand, diminish the intensity of the red component, the resulting colours of the combination will pass through greenish yellow, yellowish green, and so to pure green. Similarly, by mixing green and violet light, we shall produce the whole range of blues, and so on. We have said above that, while the theoretical three sets of nerves are to a very great degree respectively sensitive only to the three primary colours—red, green, and violet—yet that each is also affected slightly by the two remaining colours not specially pertaining to it. Hence, under ordinary circumstances, a very small quantity of white light must be mixed with every colour we perceive, diminishing to that extent its intensity or saturation. And that this is the case even with the colours of the spectrum a simple experiment, devised and described by Helmholtz will suffice to show. We can tire a nerve just as we can tire a muscle. If we go out into the bright sunshine, and then enter a darkened room, for some time we can see nothing at all. Our retinal nerves are so fatigued with the glare of the sun as to be absolutely insensible to the faint light reflected from objects in our dimly-lighted chamber. By and bye, when the eye becomes, as we say, accustomed to the darkness, we can see perfectly, and even read, where on our first entry nothing whatever was visible. On a cognate principle, if we stare at a brilliantly-lighted church window for a minute or so, and then turn the eyes towards the grey wall, we shall see an image of the window of the identical size and form of the original, but with white for black and black for white, like the negative of the photographer. The glare of the light transmitted through the glass has tired out the retina, and those parts of it upon which that glare has fallen are less sensitive to the light reflected from the grey wall than its other portions, hence there appears the dark image of the window-panes upon the uniform surface. Thus much in preliminary explanation of the experiment of Helmholtz, who gazed upon bright bluish-green until he quite tired out his retina as far as that colour was concerned, making himself, in fact, practically green-blind and violet-blind. Regarding now the red of the spectrum, the after-image of the bluish-green appeared of such a burning and effulgent red that the adjacent red looked actually whitish in comparison! We shall have something more to say of coloured "ghosts" in a future paper in connection with the subject of complementary colours. We shall see too how indefinitely our range of colours producible by mixtures of the three primary ones, is extended by mere changes in luminosity. For the present, what we have here said must suffice.

ROYAL VICTORIA HALL, WATERLOO BRIDGE-ROAD, S.E.—A grand Eastern spectacle, entitled "King He's Abore, the Plague of His Dear-mah," is being prepared for the Christmas entertainment at the above hall. It is replete with splendid scenery, including the Enchanted Valley of Palms and Precious Gems, the Abode of Evil Spirits, the Grand Palace of King He's Abore. Beautiful dresses, electrical and sensational effects will be amongst the attractions of the entertainment, which will be produced under the personal superintendence of Mr. Frank Wright, assisted by a company selected from the principal artistes of London and the provinces.

THE STORY OF THE HEAVENS.*

THIS is a most disappointing work. We opened it rejoicing in the thought that now at last we had a volume which we could name in answer to the multitudinous inquiries of young students for a really trustworthy and at the same time interesting and instructive treatise on astronomy—yet with some misgivings that as in other cases where surveying astronomers had attempted the work of astronomical teaching a rather dry and uninviting book might have been produced. But our disappointment has been more complete than this natural fear suggested as possible. The book before us has little interest in the way of descriptive astronomy, its supply of solid food is of the most indigestible sort, and the theoretic and speculative matter is not only very questionable but relates to subjects of very little interest.

One or two examples of Dr. Ball's method in description and in explanation will be fairer than mere verbal criticism. As to the theoretical matter we note that beyond Tschermak's theory of meteoritic origin (unsoundly limited to ejection from the earth), and the theory of the moon's origin from earth-waves (which the time-element negatives, as here advanced) there is little to attract attention.

Here, then, is the description of those most interesting of all celestial objects the rings of Saturn:—

"The various features of the rings are well shown in the beautiful drawing of Trouvelot. We here see the inner and the outer ring, and the line of division between them. We see in the outer ring the faint traces of the line by which it is divided, and inside the inner ring we have a view of the curious and semi-transparent crape ring. The black shadow of the planet is cast upon the ring, thus proving that the ring, no less than the body of the planet, shines only in virtue of the sunlight which falls upon it. This shadow presents some anomalous features, and its curious irregularity may be, to some extent, an optical illusion. The drawing contains no trace of those other and finer lines which are more or less problematical, but it is a faithful representation of the planet, under good seeing conditions, and viewed in a telescope of considerable power. There can be no doubt that any attempt to depict the rings of Saturn can only represent the salient features of that marvellous system. We are situated at such a great distance that all objects not of colossal dimensions are invisible. We have, indeed, only an outline, which makes us wish to be able to fill in the details. We long, for instance, to see the actual texture of the rings, and to learn of what materials they are made; we wish to comprehend the strange and filmy crape ring, so unlike any other object known to us in the heavens. There is no doubt that much may even yet be learned under all the disadvantageous circumstances of our position; there is still room for the labour of whole generations of astronomers provided with splendid instruments. We want accurate drawings of Saturn under every conceivable aspect in which it may be presented. We want incessantly repeated measurements of the most fastidious accuracy. These measures are to tell us the sizes and the shapes of the rings; they are to measure with fidelity the position of the dark lines and the boundaries of the rings. These measures are to be protracted for generations and for centuries; then and then only can terrestrial astronomers learn whether this

* "The Story of the Heavens," by Rob. S. Ball, Astronomer-Royal of Ireland. Cassell & Co., London, &c.

elaborate system has really the attributes of permanence, or whether it may be undergoing changes of marvellous rapidity, when the gigantic nature of the objects involved is considered."

It appears to us that the average reader can easily see, for himself, the features mentioned in the first part of this descriptive (?) passage; and half a page devoted to an account of what the reader would naturally like to know, but cannot yet be told, is just half a page wasted.

We had proposed to quote a passage illustrative of Dr. Ball's explanatory method, but we really have not space.

Take, for instance, transits of Venus:—On p. 143, he tells in a paragraph of half a page that there are such and such bodies in the solar system (which the reader already knows from the book itself); in another, equally long, that we cannot fully understand a map unless we know its scale; in a paragraph of three-fourths of a page that one can make a plan of the solar system without knowing its scale. (In the body of this paragraph is a sentence quite out of place, repeating that transits of Venus will give the scale of the solar system.) One-third of a page shows that when Venus is passing between us and the sun she may be seen on his face. But we learn in two-thirds of a page that she may not, because her plane of travel is inclined to the earth's.* So on and on for page after page—the only attempt at the explanation of the actual transit problem being contained in a paragraph pointing out that if one changes position in a room the window-bars change in apparent position on the distant landscape, followed by remarks showing that the same sort of thing must happen with Venus on the sun. Not one definite statement is made as to dimensions, durations, or the like. (In the earlier and still more general account there are several inaccuracies; for instance, we are told that "the remarkable eight-year period *necessitates*" that a transit in any year shall be followed by another eight years later, which is by no means the case.) Then the old story of early transit observations is repeated—quite properly, of course—after which four pages are given to an account of the observations at the Dublin Observatory during the transit of Venus in 1882, made under very unfavourable conditions and without anything of the least importance being noticed. After, in all, seventeen pages, scarcely containing half a page of real matter, Dr. Ball remarks that it is not possible for him, "with a due regard to the limits of this volume, to linger any longer over the consideration of the transit of Venus." But further Dr. Ball persists in lingering. "When we begin to study the details of the observations we are immediately confronted with a multitude of technical and intricate matters. On the occasion of a transit, it has first to be decided where the observations are to be made—in itself a question that has led to no little discussion. Then the instruments that are to be used, and the description of observations to be made, have to be investigated with considerable complexity. The observers must be specially trained for the work, for even Methuselah himself could hardly have lived long enough to have had much *practice* in the observations of transits of Venus. To compensate for the inevitable want of experience, the observers had to be prepared by a special course of instruction, in which a fictitious transit was observed. Then, too, the interpretation of the observations involves many thorny and many controverted questions. To pursue all these matters so as to render them intelligible, would lead us into great detail and therefore we do not make the attempt. This course (*sic*) is the more advisable when it is remembered that the transit of Venus is only *one* of the methods of finding the sun's distance—a celebrated one, no doubt, but not perhaps the most reliable. It seems not unlikely that the final determination of the sun's distance will be obtained in quite a different manner. This will be explained further on," "and hence we feel the less reluctance in passing away from the consideration of the transit of Venus as a method of celestial surveying."

Dr. Ball is a powerful mathematician, an able and doubtless faithful observatory chief; but he has not done his readers or his publishers justice in the book before us. We are not to know on what terms, generous or the reverse, this book has been written; but for his own credit's sake Dr. Ball ought not, we conceive, to have devoted page after page, in the style we have sampled, to tell his readers that he is unable to tell them what the student of astronomy would naturally like to learn. Those students whose inexperience leads them to imagine as they read page after page of such nothings, that they are following explanations and gaining information, have not been quite fairly treated.

* Two-thirds of a page, and more, might quite reasonably be given to *elucidating* this point; but Dr. Ball does not elucidate it at all. Here is a part of the passage, (the bulk is like the sample):—"If it should happen that Venus overtakes the earth at or near either of the points (!) in which the plane of the orbit of Venus passes through that of the earth, then the three bodies will be in line, and a transit of Venus will be the consequence. The rarity of the occurrence of a transit need no longer be a mystery," &c. A figure showing what is meant, and definite reference to the positions referred to in the description, would have occupied no more space than the paragraph, and would have been far more instructive.

NEWTON, HIS NAME AND FAME.*

IT may be reasonably questioned how far we have any right to inquire into the private life of those from whose thoughts or labours we have profited. That the private lives of kings and queens and other such persons (who are thought to do well when they do no particular mischief) should be inquired into, is right enough; for the nations do not profit by them, and they cost a good deal; so that in their case the world has rights for which it has paid more than a fair equivalent. But the case is otherwise with the great.

There can be no doubt, however, that if accounts are given to the world of the lives of men like Bacon and Newton, Shakespeare and Milton, Priestley, Davy, and Faraday, such accounts should be carefully freed from all that is false or misleading. It is bad enough to pry into the private lives of such men at all; but certainly it is much worse to spread untruths about their lives, even though this be done through mere carelessness; and it is worse still if falsehoods are spread wilfully.

We are glad, therefore, to see that the inquiries made by the late Professor De Morgan into details of the life of Newton have been at length published. For undoubtedly the present work will serve to clear up certain points which were left in doubt after the publication of Sir David Brewster's later and larger book on Newton.

De Morgan devotes the greater part of this work to the matter of Lord Halifax and Newton's niece. The enemies of Newton and even some who—like Voltaire—were genuine admirers of his genius, adopted the belief that Miss Barton was Lord Halifax's mistress. Sir David Brewster and others who have simply sought to clear Newton at all hazards, have endeavoured to show

* "Newton: his Friend and his Niece." By the late Augustus De Morgan. Edited by his Wife, and by his pupil, Arthur Cowper Ranyard. London: Elliot Stock.

that Miss Barton never lived in the same house with Halifax. Lord Macaulay and others have advanced the idea that Miss Barton's relations with Halifax were akin to those of Mrs. Unwin with Cowper, and of Mrs. Bracegirdle with Congreve. De Morgan maintains the theory that Lord Halifax and Miss Barton were privately married. It appears to us that De Morgan has fairly made out his case. Sir David Brewster's theory is simply absurd on the face of it, as is indeed Brewster's position generally in regard to Newton. Probably no biographer has ever in an attempt to defend a great man through thick and thin, done more to injure his reputation than Sir David Brewster has done to injure Newton's, by fatuous attempts to deny what is shown by the clearest possible evidence to have actually happened. No one probably believed that Newton had consented to profit by the degradation of his niece, until they found Sir David Brewster denying flatly what was well-known and admitted in Newton's lifetime. It is certain that Miss Barton lived in the same house with Lord Halifax, that her association with him whatever its nature was greatly valued, and that for this reason he left her at his death a large sum of money and a valuable house. It is also certain that he had already bought for her an annuity which in those days amounted to a handsome income, Newton acting as his agent in the matter. Nothing in all this would seem suggestive of evil to those who (being themselves of honest mind) recognise the quality of Newton's nature—far from being perfect but free from inherent vice or depravity. So soon, however, as Sir David Brewster attempted to deny these demonstrated facts, even the most zealous admirers of Newton, the most honest believers in his purity, began to fear that after all Newton *must* have trafficked, as Voltaire had openly suggested, in his niece's shame.

The real fact is, however, that Newton *was* blameworthy, though in small degree. Sir David Brewster had gone far to bring utter opprobrium on his hero by trying to deny that he had done aught amiss. Brewster had actually written to De Morgan that, as Newton's biographer, he would at all hazards deny what would seem reprehensible in Newton,—"every means of defence against such an hypothesis" he says, speaking of Newton's real weakness in the matter, "becomes obligatory on me as his biographer,"—which indicates about the most foolish idea a biographer could possibly entertain.

De Morgan shows that in all probability, almost certainly in fact, Lord Halifax and Miss Barton were man and wife, and that this was known within a small circle of relatives and friends. That Newton's suffering his niece to lie under the stigma of imagined concubinage when really married, would not be thought a grave offence or even an offence at all in those immoral times, is clear enough, whatever some ignorant folk ("clergymen and persons of rank" he says) may have told Brewster to the contrary. That Newton himself knew that he owed more faithful guardianship than this to his niece, can hardly be doubted. He was blameworthy, no doubt, but not guilty of the foul offence which Sir David Brewster's fatuous defence had seemed to bring home to him.

That Miss Barton was married to Lord Halifax is shown by his own continued respect for her, and the esteem in which all held her who knew them both; by the tone of the Montague family towards her and Newton after Halifax's death; and by many collateral circumstances.

More important, though occupying less space, is De Morgan's discussion here of several points connected with Newton's scientific career. He takes a fair view of Newton's character, neither attributing to him, as some have done, the whole discredit for the acrimonious dispute with Flamstead, nor acquitting him, as has still more unwisely been attempted, of all blame there or elsewhere. Newton was unquestionably a man of jealous and suspicious temperament, capable of occasional meanness as all such men must be, but controlling his own nature for the most part with such care as to deserve more credit than would have been due to him had he inherited an easier nature. His zeal for science was not great enough to urge him to laborious research after he had made his name great, and had gained, besides fame, a lucrative post. His career affords, in fact, the strongest proof of the folly of those who imagine that science can be effectively advanced by endowment; for from the time when his lines were made easy by a lucrative appointment, by no means taxing his time or energy in such degree as greatly to diminish his opportunities for original research, Sir Isaac Newton did nothing for science. *We owe to endowment, in Newton's case, the loss of all that that wonderful mind could have done during the best part of a lifetime.*

Gossip.

By RICHARD A. PROCTOR.

IT should be clearly understood by this time that if readers send cheques, stamps, instructions, and so forth, to the editor of KNOWLEDGE—*i.e.*, to me, Richard A. Proctor—instead of the publishers, they give a great deal of useless trouble, and they incur the risk of remaining unattended to. The publishers receive an immense number of letters, and have to sort out those belonging to the various editors, authors, contributors, &c., of the different magazines, works, &c., published by them. Here is risk No. 1: a letter intended for KNOWLEDGE editor *may* (though the chance is slight) be sent to some one else, and not reforwarded. Then, next, letters for the editor of KNOWLEDGE still come in in great numbers. Hence risk No. 2; among the multitudinous letters he receives, nine-tenths of which might as well not have been written, the editor may chance to overlook (especially now that he does not give a column of replies) the one which contains a business letter. (I found one the other day in a book sent for review.) Then comes risk No. 3. Such business letters are put on one side to be forwarded to the publishers. But the editor travels about a good deal. (He will have given twenty-nine lectures for example at "all sorts of" places during the four weeks ending December 20.) It is always possible, in the midst of constant travel, lecture arrangements, lecture correspondence, &c.—combined with book-writing and correction, preparation of new editions, essay writing, study, correspondence, exercise, occasional attempts at relaxation (a mere detail, perhaps), and some few moments passed in association with his family,—that letters thus set aside to be sent to the publishers may be mislaid, or lost in what the late Abbé Moigno pathetically described to the editor as the "bottomless sea of papers and letters." If delay or loss should arise in that way the editor is apt to be energetically abused. He ventures to point out that considering the multitudinous instructions given during more than four years on this point, it is he who—were he not a

long-suffering sort of a fellow—should do the abuse,—not get it.

* * *

SIMILAR remarks apply to manuscripts. Those who send unsuitable manuscripts, bearing no address (address in accompanying letter is useless) and without stamps for return, expecting that when, perhaps three months later, they apply for their MS., it will of course be forthcoming, prepare for themselves sure and certain disappointment.

* * *

I HAVE received from several well-meaning persons, letters begging that I would avoid all remarks such as those upon Dr. Payne Smith's commentary on the Book of Genesis, and keep carefully out of KNOWLEDGE all such writings as Mr. Clodd's "Story of Creation," my own "Science of Religion," and Mr. Allen's charming evolutionary papers, and in fine so far as I can judge, everything which would not have been thought fit for young children fifty years ago. Some who write thus, give as the reason likely to be most effective, their impression that KNOWLEDGE would have a much wider sale if its pages were thus specially fitted for the nourishment of babes and sucklings.

* * *

NOW I prefer it to be thoroughly understood that the tone given to KNOWLEDGE depends solely upon my sense of what is best. KNOWLEDGE endeavours to show that the teachings of the science of our day are not subversive of religion, however corrective they may be of religionism. The children in a Sunday-school, or young girls in a seminary of the conventual type, would of course not be benefited by passing suddenly from the simple teachings which have suited them to those which the more advanced require. But this is so only in the sense in which the lessons of the Differential Calculus (for example) are unsuited to the boy who is advancing from Addition and Subtraction towards Long Division. One might reasonably urge that a statement respecting "Taylor's Theorem" would be confusing to Johnny Noakes or Polly Styles, subtracting 17 from 51, and perhaps getting 23 for the difference. But a treatise on the Differential Calculus is not meant for those young and as yet not very intellectual persons. And the Differential Calculus is not only not inconsistent with all that is true in Subtraction or Multiplication, but emphatically requires that these processes shall be true and truly effected (that the taking of 17 from 51 shall leave 34 and not 23).

* * *

I CANNOT keep out of these pages Mr. Williams' account of coal because it is not a description of the domestic fireplace, nor "F.R.A.S."'s optical papers because they do not tell us that the fields are green and the skies blue, or Mr. Allen's essays because he does not tell us such things as we used to find in Mavor's Spelling-book, nor Mr. Clodd's because his Story of Creation is not that which in the childhood of the human race seemed all that was necessary to be known or suggested as perhaps possible. If it is the case, as no doubt it is, that there are many more ill-informed and child-like persons in the community than there are of those who know more and think at least a little, then so much the smaller for the present is the community for whom we work. But most assuredly we are not going to pretend to write for the community of thinking persons, and in reality to supply matter only for those who mentally and morally are but as children. It is no doubt a most desirable thing that these should be taught; but we have undertaken other work.

* * *

A NEW interpretation may be suggested for what was said of old, "Let the dead bury their dead,"—to wit, let those who give their best energies to the study of the dead languages bury their dead beliefs under them. Albeit this must be limited to those who make that study the end of their work: those who study the dead languages of the Assyrians, Egyptians, and so forth, that they may interpret better the histories and the thoughts of ancient races, are doing most important work.

* * *

IT is rather amusing to contrast two remarks in last month's KNOWLEDGE, one by Mr. W. Mattieu Williams, the other by Mr. Clodd:—

Says Mr. Williams, "Modern scientists who discuss dogmatically the properties of imaginary entities should be warned by the fate of poor old phlogiston or fire-ether, and study its philosophical analogy to the luminiferous ether."

But Mr. Clodd remarks that for the explanation of certain "varied and yet related phenomena, it is a necessary assumption that the minutest intervals between atoms, as well as the awful spaces of the universe, are filled with a highly rarefied, elastic medium called ether, which, ever tremulous with unentangled vibrations, is the vehicle of energy, alike from the infinitely great and the infinitely small."

* * *

IN reality, Mr. Williams overlooks the real analogy, which is between the ray theory of light and heat and the poor old phlogiston. It was the old theory of the emission of something real in the form of rays, a theory which, wrong though it was, found favour with Newton and other distinguished men, which might fairly be compared with the idea of phlogiston. The theory that heat and light are modes of motion, which displaced the idea that they are actual substances, required that they shall be regarded as traversing interplanetary and interstellar space (as they unquestionably do traverse such space), by vibrations in *some* medium,—and the ether is simply what we call that medium. No "properties" have ever been assigned to that ether, either dogmatically or otherwise, except such properties as we recognise from the manner in which vibrations pass through it. In all that science has asserted about ether she is on absolutely sure ground, because every one of these properties may be tested, and has repeatedly been tested, experimentally.

* * *

MR. WILLIAMS has selected for attack one of the assumptions of science which has been advanced and maintained in the most purely scientific spirit. Assumed to interpret the peculiarities of a most complete and complex series of observations, the theory of an ether has been tested in every conceivable way, even to the calculation of what might be expected under new conditions, (sometimes of the most complex character)—and invariably the theory has been confirmed. The old theory of light which the vibration theory replaced failed early, or the theory of a luminiferous ether would scarcely have been entertained; but if that older theory had not failed then, the phenomena of diffraction and polarization would have sufficed to kill it thoroughly. I cannot imagine that any one acquainted (understandingly) with even the elementary parts of the mathematical inquiry into the wave-theory of light, can question any of the

properties which have been necessarily assigned to the ether of space.

* * *

THE idea that because we cannot actually analyse physically or chemically some particular entity (whose very nature may place it outside such analysis) we therefore must not admit its existence, is altogether unscientific. (In Mr. Williams's case there is I know the belief in highly attenuated air to conflict with the acceptance of ether—an excuse though not really a reason: but I do not care to remark upon his attenuated air theory beyond saying of that air that it is *too* thin.)

Consider the following example:—

There is a bowl of glass which we know to be such because we can study its outer surface; but we cannot examine its interior, nor test its weight, because it is fastened by some rigid support. We move so that a light is seen through the globe, and then moving the eye sideways find the light draw near the edge in *the same direction*, but never actually reach the edge: we are now justified in assuming that the globe is only a shell of glass with air or some other medium much rarer than glass inside. This assumption is absolutely sound, in this general form. More careful observation may enable the mathematician to say just how thick the glass shell is, and just what refractive power the medium inside possesses. Supposing this refractive power to be that which air at the average sea-level pressure possesses, the observer might infer with considerable probability that there was air within the shell. But on this point he could not be certain; for other gases than those in air might at certain pressures have the same refractive power.

* * *

OR "put it my juvenile friends," as the unctuous Chadband hath it, that our observer on moving his eye to the right found the light pass off to the left, until, moving continuously but not uniformly to the left (as his eye moved uniformly to the right) it came right up to the very outline of the disc presented by the bowl. Then he would be justified in inferring that the bowl was not a mere shell of glass, and that, if not a globe of uniform glass throughout, its interior varied continuously in density, not by any sudden or abrupt change as from water to glass. If he found the final direction of the light when seen on the very verge of the disc to correspond to the direction due to the refractive power of glass of the same quality as the tested outside of the globe, he might infer with considerable probability that the globe was throughout of the same material. But this would not be absolutely certain.

* * *

IF, however, he found that while his eye moved uniformly to the right the light moved continuously up to a certain distance from the edge of the disc presented by the bowl, then became indistinct for a moment, and presently was seen nearer the edge and eventually came right up to it,—then the observer would be justified in assuming that there was a shell of glass, enclosing a medium of somewhat smaller refractive power, as water, for example. He might be able to determine observationally the precise thickness of the glass shell; and further, assuming that the medium within was really water, he might, by a series of observations, test this assumption. If he found that the medium certainly was not water, and had not the refractive power of any substance he had tested, it would still be a demonstrated fact that there was some medium of such and such refractive power within the shell.

* * *

IN like manner it is a demonstrated fact that there is a luminiferous medium, possessing such and such properties,—but its actual nature not wholly determined or probably determinable. To dogmatise as to the undetermined properties of this ether would be an unscientific proceeding; but to doubt the demonstrated properties is to indicate want of power to appreciate the investigations (certainly rather recondite in parts) by which these properties have been ascertained. Precisely so, to take a much easier subject, an imagined student of our illustrative bowl would not act as a scientific man should, if he assumed in the third case that the enclosed medium, as yet undetermined, had such and such chemical properties; but for him to doubt its refractive power would simply indicate his inability to understand the laws according to which rays of light pass with refraction, from all but tangential contact *into* a spherical glass shell, full of a medium nearly as refractive as itself, and thence tangentially *out* of it.

* * *

OF course inability to understand such a simple experiment as this (the reader can readily try it with a globular decanter—or a tumbler will do—first empty, then full), and inability to follow such difficult mathematical calculations and such delicate physical experiments as have been used to establish the undulatory theory of light and to demonstrate the general qualities of the luminiferous ether, are very different matters: but the principle is the same.

* * *

THE advocates of the "poor old theory of phlogiston" opposed, through precisely such unreadiness to admit the force of evidence, the introduction of the theory that heat is not a substance but a mode of motion. So did the advocates of the emission of some actual matter in rays oppose the undulatory theory of light. But their objections remain now merely "to point a moral or adorn a tale."

* * *

ON the other hand, I do not feel quite so clear that my friend Mr. Clodd has been well advised in giving new definitions and altered meanings to the much misused words Force and Energy. Of course, as he does define, very precisely, the sense in which he proposes to use the words, the reader of his thoughtful essay need not care to consider whether the words *should* be so understood generally or not. In the well-known story of the undergraduate under examination who had in a descriptive answer written throughout of seven somethings (I forget what) where, as he remembered towards the close he should have said five, that ingenious examinee to save the trouble of going through his reply and correcting every "seven" into a "five," made all right by prefixing this note, "In the three following pages let the symbol 7 represent 5, and let the word "seven" represent the word "five." So, but with intention aforethought, Mr. Clodd, at Mr. Allen's suggestion, gives meaning to his remarks about Force and Energy by explaining at the outset that in what follows the word "Force" stands for something akin to what is ordinarily called "Attraction," and the word Energy for "Repulsion." All the reader has, then, to consider is whether the statements so understood are correct. It is to be feared, perhaps, that the confusion which has appeared in certain important philo-

sophical essays between the "Conservation of Energy" and a property—unknown (at least as a general property) to exact quantitative knowledge—entitled the "Persistence of Force," may fail to be cleared up when new meanings are given to the words Force and Energy; but perhaps that difficulty may be avoided.

* * *

Speaking as a student of mathematical mechanics, to whom the constant use of words in the same meaning is of some importance, I may note here that in the mathematically mechanical sense Force and Energy are quite distinct. Whatever causes or changes motion we call *Force;* the effects of Force we call *Work;* and *Energy* is stored *Work*, whether in change of position or in generated motion. The word *Power* is used only in relation to mechanisms.

* * *

The fulfilment of the prediction made in November, 1872, with regard to Biela's comet, and the occurrence of yet another display of meteors following in the track of that comet on November 27th last, must have removed all possibility of doubt as to the actual connection between the meteors of November 27, 1872, November 28, 1878, and November 27, 1885, with the divided and eventually dissipated comet which appeared in 1826, returned in 1832, 1839, 1846, 1852, 1859 possibly, but not in recognisable form in 1872, 1878, and 1885 as it would but for disintegration.

* * *

In discussing the movements of the meteors seen on the night of November 27th, some members of the Astronomical Society touched on the theory—quite inadmissible, it seems to me,—that Biela's comet and meteor stream may have been ejected in remote times from the earth in the sunlike state. Say Jupiter, and the idea is likely enough.

* * *

Our contributor who prefers "Bill, Tom and Harry," to "Bill, Tom, and Harry", asks if we have not blundered in saying that such a sentence as "The Greek, Roman and English, have fought for liberty" is nonsense. Would "Bill, Tom and Harry, walked to town" be nonsense? he asks. In our opinion it would actually *be* nonsense, though it would be understood sensibly enough. Once it has been shown that the omission of the comma is essential for a particular meaning, its omission must be understood to imply that meaning, which in either of the sentences just given is absurd.

* * *

I have noticed many cases in well known writers, since I last wrote on the subject, where this point of punctuation has come in. As an example take the remark made by that very foolish person Silas Lapham, that that inconceivably snobbish hero Mr. Thomas Corey, has "an honest, fair and square face." The necessity for omitting the comma here implies the necessity for introducing it in such a sentence as "Tom Corey has a supercilious, conceited, and bumptious manner."

* * *

Mr. Howell's idea by the way of a refinement is amusing. The descendant of the Coreys (a sort of Norfolk Howard or "big bug" family it would seem) shows his refinement by discussing with his even more snobbish father, and with his unutterably coarse mother and sisters whether the lady he is supposed to love, is worthy of his aristocratically refined affections!

New Books to be Read—and Why.

King Solomon's Mines. By H. Rider Haggard. (London: Cassell & Co.)—Because the story is full of interest and, though relating chiefly to an imaginary race of Africans, gives a good idea of life in Africa. Probably young readers may be led to suppose that there really is such a race as the Kukuanas, so natural is Mr. Haggard's narrative in all that relates to travel, customs, and the like. The fighting is a trifle complicated, however, and in particular the combat between Twala and Sir Henry Curtis is rather too much in the style of the great fight in the "Legend of the Rhine" (if only Twala had made a few remarks after his head was removed, the resemblance would have been perfect). The behaviour of the sun and moon in Kukuana land is remarkable. The sun has scarcely set when the fine crescent of the moon rises in the east. This, to say the least, is unusual. But a crescent moon which could thus face the sun would do anything; so that we are not greatly surprised to find the moon full next night; and eclipsing the sun the day after. The eclipse of the sun, also, is remarkable; for total darkness lasts for nearly an hour. We do not have such solar eclipses, or such a strangely acting moon, outside of the neighbourhood of King Solomon's Mines. No wonder they have not been found except in fiction. Possibly they never will be.

Tiryns. By Dr. Henry Schliemann. (London: John Murray. 1886.)—Because, in this account of his excavations and discoveries in the prehistoric Palace of the Kings of Tiryns, Dr. Schliemann extends and developes that knowledge of a period lost in the mists of the hoariest antiquity, for which we are indebted to his former researches in Mykenæ and Troy; and shows us something of the vast architectural resources and considerable artistic taste of a people whose very existence has been conceived to reside only in myth and legend.

Methods of Research in Microscopical Anatomy and Embryology. By C. O. Whitman, M.D. (Boston: S. E. Cassino & Co. London: Trübner & Co.)—Because it contains in a succinct, readable, and thoroughly intelligible form as comprehensive a series of instructions as we have seen for the histologist and embryologist. Mounting, staining, section-cutting, injection, the rearing of various forms of organic life, &c. for embryological research, &c., &c., amply illustrated and well indexed, are some of the subjects treated of in a volume invaluable to the physiological microscopist.

A First Course of Physical Laboratory Practice. By A. M. Worthington, M.A. (London: Rivington. 1886.)—Because it is a most intelligently-written and admirably-arranged book for all incipient students of physical science, and may be thoroughly recommended as a trustworthy introduction to more pretentious works on the same subject; such, for example, as Glazebrook and Shaw's "Practical Physics" in Longman's series.

Our Land Laws as they are. By H. Greenwood, M.A. (London: Sampson Low, Marston, Searle, & Rivington. 1885.)—Because it contains the best popular account that we have so far seen of the existing laws which regulate the possession and tenure of land in England—a subject on which an enormous amount of nonsense has been but too recently uttered. Mr. Greenwood strives earnestly to be impartial, but professional prejudices perforce peep out here and there. No layman certainly can

read the account of copyhold tenure without regarding it as as great an anachronism as the ordeal by fire, and as a simple scandal to our vaunted advancement in this nineteenth century.

History of Homœopathy. By W. AMEKE, M.D. Translated by A. E. DRYSDALE, M.B. Edited by R. E. DUDGEON, M.D. (London: E. Gould & Son. 1885.)—On the principle *Audi alteram partem.* Having, doubtless, heard Hahnemann and his followers denounced as Charlatans, the reader may here learn (on the authority of the Trinity of Homœopaths whose names appear on the title-page), how every one who opposes or ever has opposed their fetish, can only have been actuated by sinister motives. Notably does Dr. Dudgeon seem to suffer under the hallucination that no man can possibly reject homœopathy from pure and disinterested motives.

The Diseases of Sedentary and Advanced Life. By T. MILNER FOTHERGILL, M.D. (London: Baillière, Tindall, & Co. 1885.)—Because it contains a whole mass of information of the highest value and importance to the very large class which it addresses. Not only is it written in a style to render it most helpful and instructive to the lay reader, but it contains much which will be found useful by the medical practitioner. It is an eminently practical book.

There also lie before us, each addressing its own public, CLARK'S most useful *Transit Tables for* 1886. (London: E. & F. N. Spon.) *A Digest of English History* 1760–1815. By M. GUTTERIDGE, B.A. (London: Relfe Brothers. 1885.) *A Handbook of French Composition.* (London: E. Stanford. 1885.) *Wilfred and Marion,* a drama in five acts. By EVAN ALEANDER. (London: Tinsley Brothers;) and a *Chart of Ancient Greek History.* (Edinburgh and London: W. & A. K. Johnston.)

Diaries.—Among the Diaries published for 1886 we must specially commend the Court Diaries in four different sizes issued by Griffith, Farran, & Co. (very full and convenient); Blackwood's excellent shilling Scribbling, Foolscap Octavo, Tablet, and Penny Pocket Diaries; and Pettitt's Scribbling and Octavo Diaries, both of which are capital.

SEASONABLE NOVELTIES.—The present season is generally regarded, for some occult reason, as an occasion for the giving and receiving of presents, perhaps in order to accentuate that "peace and goodwill" which is a special feature of Christmastide. But, however that may be, those desirous of giving presents to young people could scarcely make a better selection than the "Guinea Christmas-box" issued by the London Stereoscopic and Photographic Company, of Cheapside and Regent-street. It is equally amusing and instructive, and contains as many as sixteen varieties of scientific toys, puzzles, interesting games, and bewildering conjuring tricks. Another novelty, for which the protection of the patent office has been obtained, is one that will undoubtedly secure recognition in the daily-increasing ranks of amateur photographers. This is the "Amateur Travelling Bag," which is fitted with every requisite necessary for the production of photographs, while it preserves the external appearance of an ordinary travelling companion; thus securing the immunity from observation which is so dear to many people. The Stereoscopic Company have also published a handsome portfolio comprising a tastefully-mounted selection of the photographs which were prize-winners at the exhibition of amateurs' work held a few months ago in Bond-street—an exhibition which owed its success chiefly to the enterprise of the company. The pictures in the portfolio under notice are arranged in accordance with the classes in which they were originally exhibited, and are accompanied by the artists' names, and other detailed information. A visit to the company's premises will be amply repaid by the opportunity afforded of inspecting their choice collection of photographs, comprising portraits, groups, and landscape-work.

Our Whist Column.

LEAD FROM ACE FIVE.

BY MOGUL.

ABOUT twenty years ago, I ventilated in the *Field* my objections to the lead of Ace from Ace and four small ones. The discussion that ensued was inconclusive, because certain probabilities affecting the question had not then been calculated, and my arguments fell on barren soil. They nevertheless appeared to me so weighty, that it has been my practice ever since to lead a small one from Ace and four others, except when one of the four is the Queen or Knave, in which case I lead the Ace. My objections to the lead of the Ace were (1), that it deprived my partner of all chance of making the Queen, if held either singly or with one other; if alone, it fell to my Ace; if singly guarded, it fell to the adversary's King whichever side the King was held, and in cases where the Queen was doubly guarded, it either fell on the second round to the fourth player's King, or, if it survived to the third round, not only would it block my suit, but would almost certainly be trumped, as one of the adversaries must run short in the third round. (2.) It diminished the chance of at once establishing the suit by getting three rounds out, as it was two to one against a partner holding the King on the second round, whereas it was nearly an even chance that he would win the first trick; and (3) if partner proved weak it gave up the lead and the entire command of the suit merely to secure one trick in it, and deprived the Ace of one of its greatest uses—viz., the capturing a good card of an adversary; and these objections were encountered solely because one of the adversaries might hold one only of the suit, and consequently might trump the Ace on the second round. This always appeared to me an insufficient reason; but when the Queen or Knave was one of the four others, my objections were so much less forcible that in that case I have continued to lead the Ace. The result, so far as I can judge, has been so very satisfactory that, unless it can be shown on an exhaustive calculation of the chances of gain or loss, that the probability of loss by leading a small one is really serious, I should, on the strength of my experience, advise players to lead a small one from Ace five, unless one of the five be Queen or Knave. That this can be shown is very unlikely, for since I wrote Pole has calculated the chances of the leader (holding Ace Five) making one trick in the two first rounds of the suit accordingly as he begins with the Ace or a small one, and the result he arrives at is that one trick will be made eight times when Ace led for every seven times it will be made when a small one led. Now, although I cannot quite follow Pole's figures, and think that the difference is not so large as he makes it, for he assumes that the Ace will always be trumped in the second round when either adversary fails, whereas this would not be the case when the suit is returned by partner and the adversary failing is then second player; I still consider that, taking his result as correct, the advantages accruing from the lead of a small one, especially the increased chance it affords of getting three rounds out and at once establishing the suit, more than outweigh, in each case, the loss of one-eighth of a trick, *i.e.*, the lead of a small one will in eight times be the means of gaining, as compared with the lead of the Ace, more than one trick.

The lead was considered in your Whist Column of June 12, 1885, but the writer there makes the same mistake as Dr. Pole in assuming that the original fourth player, when he fails in the second round, will, as a matter of course, trump the suit when led on his right. Re-arranging the figures there given, I find that the Ace will make on second round twenty-two times for every twenty-seven and a half times it would make if led out in first round. This would be the loss of about the fifth of a trick every time a small one is led; but this seems to me fully compensated for by the increased chance it gives of the Queen, if held single or with another, making in the first round, and I find on calculation that the chances of making the two first tricks in the suit are equal, whether Ace or small one be led, but when it is considered that more tricks would be made in the two rounds when a small one is led, were it not that the adversaries will now and then trump the ace on the second round. Have we not a right to assume that this expenditure of a trump will, in a certain proportion of cases, say half or one-third, lose our adversaries a trick in other ways? Now and then it may prevent an adversary getting in his long suit and enable your partner to get in his. The conclusion that, on the whole, the lead of a small one is advantageous, is, I consider, irresistible, and certainly it is more in harmony, than is the lead of the ace, with the principles which regulate a lead from a long suit headed with one high card.

Our Chess Column.

By Mephisto.

FOUR-HANDED CHESS.

As may be seen, the board in the four-handed game consists of three additional rows on each side, making altogether 160 squares, and the game is played with four sets of men of different colour, by four players.

Two players always play in partnership together, that is to say, the two sitting opposite each other play against the two players on their right and left respectively, who are likewise partners. Thus White and Yellow are partners playing against the two partners Black and Red. The game is won when both partners are check-mated.

The pieces of two partners have virtually the same powers. They support each other, but cannot attack nor take each other; thus, for example, the Yellow Q could not give check to White's K; nevertheless each player may only move his own pieces.

The principal feature of the game is that both partners co-operate both for offensive as well as defensive purposes against the two allied adversaries. To give a better idea of the complex nature of the game, we must assume that the middle of a game has been reached; it being White to move, White must, in the first instance, see whether Black threatens him, whether Red can after he has moved make a move against White, which Black can subsequently support when it again comes to his turn. White must also see whether his partner, Yellow, is threatened in a similar way, and he must attempt to penetrate the designs of Black and Red. The four Queens are always on four white squares.

The Pawns can only move one square at a time. Castling is not allowed. If the Pawns of two allies meet on the board, they may jump over each other, the same as in draughts. Apart from these deviations, the moves of the pieces are the same as in Chess.

If a player is mated, his pieces become inanimate, they can neither move nor be captured. The game proceeds as long as the partner of the mated player, singly, can fight his two opponents.

If a player is mated, it by no means follows that he must remain so for the rest of the game. Immediately the mating check gets removed he resumes play as before. A partner can, therefore, release his partner from a mate by attacking the mating piece and compelling it to move, or capturing it. In fact there may arise positions where it is a positive disadvantage to mate an adversary. For instance: White has lost his Queen. His partner, Yellow, can mate Black with his own Queen, which, however, might expose him to the strong attack of Red, White not being able to assist him much. The principal of mutual support is applied in many ways in this game. For instance, supposing it is Yellow to move in a certain position, the red K stands on K sq., Yellow may, with his unsupported Queen, check red K on K2, and in case Black can do nothing to prevent White from supporting his partner's Queen, say, for instance, by placing his B on Q3, then Red would be mated, the same as if the B on White's Q3 would be a Yellow B.

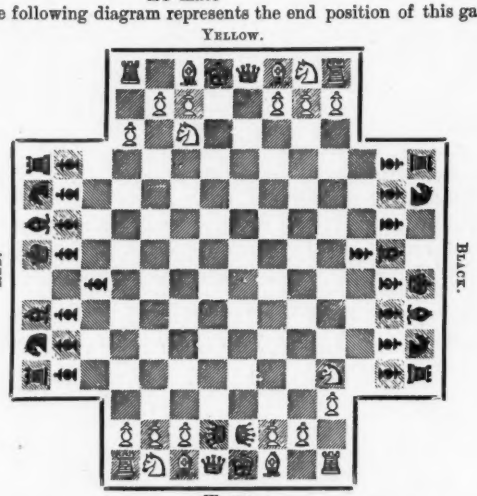
Another favourite trick of players is the following:—It is White's move; of course he can operate against Red or Black as he may think best. If he can attack Black's Queen with a Pawn or minor piece, and provided always Red cannot help his partner, Black, then Yellow, if he can do so, will check the Black King. Black, when it is his turn to move, must, of course, move out of check, which then will enable White to capture Black's Queen, which he attacked on the previous move.

Each player moves alternately from right to left; *i.e.*, White, Red, Yellow, Black, White, &c.

By drawing a temporary board on paper and with two sets of chessmen, our readers may follow the following short game, given in "Chess Excentricities," by Captain Verney:

Round.	Yellow.	Black.	White.	Red.
1	P to K3	P to Q3	P to K3	P to Q3
2	P to KR3	Q to Q2	P to KR3	Q to Q2
3	KKt to KB3	Q × Yellow QP (ch)	KKt to KB3	Q × Yellow KP mate
4		QB to Q2	KKt to KR4	Q × White QP (ch)
5		Q × White KP mate		

The following diagram represents the end position of this game:



In the above diagram it will be seen that Yellow is mated by being checked both with the Black B on Black's Q2 and by the Red Q from White's Q2. White is mated by the two Queens.

A comparison can hardly be drawn between this game and ordinary Chess. There are, however, features in this game which make it worth being cultivated; foremost amongst which must be mentioned that it engages four players instead of two, and even these may be increased to eight, by two players consulting on each side. We can quite imagine that a four-handed game—played by eight players, each side being taken by a lady and gentleman consulting together—would exercise far greater attractions in a social party than ordinary chess.

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